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ELECTRICAL EXECUTION.

The pathological examination of blood and tissues from the body of the recently executed murderer Hampton, the results of which we give elsewhere, strongly confirms the conclusion of Dr. A. H. Goelet and Mr. A. E. Kennelly as printed in our columns several weeks ago. The most important determination is in regard to the rupture of the tissues and smaller vessels of the brain which, by producing universal hemorrhages into its substance, must necessarily cause death. That the electric current, as employed in the New York State prisons for the execution of criminals, produces instantaneous and painless death is now so thoroughly established that its further discussion can only be in the interest of sensationalism.

A NEW DEFINITION.

There can be no doubt but that the monocyclic system described elsewhere will perform the functions claimed for it, and this whether it be a monophased or multiphased system. The discussion, therefore, as to whether it belongs to the first named class or the last named has no bearing on its practical merits, being a mere question of scientific definition, and one which might with benefit have been omitted from a paper having mainly a commercial end in view. The new definition of a multiphased system given in the discussion and endorsed by Dr. Bell will not pass by unchallenged. The accepted meaning is the one offered by another speaker at the time, namely, a system in which the apparatus operates through differences of phase. E. M. Fs. of different phase are produced in the monocyclic generator and it is through this that the system derives its distinctive character. The motors, also, in starting are given torque by a shifting field due to this feature of the generator. It is true that when in normal operation the system is monophased, and though this forms its most valuable point, yet we cannot see that it affects the other characteristic, subordinated though it may be to this main function. The new definition offered of a multiphased system—that it is one in which the flow of energy does not pass through zero—is not only singular in including continuous current systems, but most singular of all by eliminating from its terms the idea of differences in phase.

THE BATE REFRIGERATING CASE.

The decision of the United States Supreme Court in the Bate Refrigerating case, which we print elsewhere with a resume of the accompanying opinion, removes one of the last disturbing elements affecting the incandescent lamp and telephone interests, and the free development of these is no longer menaced by the possibility of adverse judicial decisions. As we have pointed out repeatedly in our columns, the Bate case was a forlorn hope, there being no probability that the decision of the Supreme Court would reverse the lower courts; nevertheless much apprehension seems to have existed as to the final result, which perhaps was not unreasonable in view of the apparently erratic course of our Federal Courts in dealing with patent law. The point is now definitely decided that an American inventor jeopardizes several years of the life of his domestic patent by taking out foreign patents, and the only recourse left is an appeal to Congress to right the great injustice that this involves. Had the Supreme Court been able to consider the case just decided on its equity, there can be no doubt but that an opposite result would have been arrived at. Congress, however, will not be hampered by legal trammels in its consideration of the just plea of inventors, and we believe it may be relied upon, now that the courts hold forth no more promise of remedy, to speedily right the wrong to which inventors are now subjected, provided the matter is clearly presented before it and kept in prominence by intelligent advocacy.

THE MONOCYCLIC SYSTEM.

The paper of Dr. Bell, read before the Cleveland Convention and reprinted in full elsewhere with the following discussion, is in many

respects a model of what such a paper should be for the occasion that brought it forth. Without being expressed in highly technical language it yet gives a clear idea of the technical points involved, the simple diagrams employed also largely assisting in this result. In reading the paper, however, it should be borne in mind that its object was to introduce a new system commercially before prospective purchasers, and therefore "selling points" rather than purely technical ones are naturally brought to the fore. We give this caution as otherwse it might be thought from some parts of the paper and discussion that the two and three-phased systems have been discredited in practice, which we believe to be not the case. Accepting all of the claims made for the new system, it does not propose to displace the two and three-phased systems for all work, and it would be unfortunate if its claims led to their injury. The system described is certainly a most interesting one and a beautiful example of the flexibility of the alternating current, while, owing to the manner in which it is adapted for all of the conditions of simultaneous lighting and power distribution from central stations, it promises to remove a great reproach from the alternating current due to its former lack of use for these combined purposes. Whether the weight of the objections to the employment of the two and three-phased systems for general light and power distribution, on account of lack of balance and unequal inductive drop, be of great practical moment or not, the monocyclic system offers itself as free of these objections and therefore ready to be taken up at once with confidence by central station men, who do not, as a rule, care to experiment with matters yet in dispute. The comparative simplicity of the system will also recommend it, for when the motors are once started there is no difference between it and a simple alternating system—a fact that will appeal to station managers familiar with the latter and mystified by the apparently complicated character of multiphased systems, which has been accentuated by the intricate mathematics with which their exposition has too often been accompanied. The introduction of a new armature in machines already in use, the running of a small auxiliary wire through power districts and no disturbance of present transformers or lighting circuits, are points that will have great weight, and therefore tend to make the new system a valuable adjunct in extending the usefulness of the electrical industry.

COST OF NIAGARA POWER.

We print elsewhere the offer recently made by the Niagara Falls Power Company to the municipal authorities of Buffalo as to the terms for supplying power to the latter, and which has an added interest from being the first authoritative public statement made as to proposed prices of Niagara power. While the prices quoted seem to be reasonable, considering the vast expenditure of money for rendering the power available, yet they will probably be disappointing to the public in general, in view of the popular misconception existing as to water power being immeasurably cheaper than steam power. As it is not probable that the Buffalo authorities would care to put in a generating plant at the Falls, the figure of most interest is the price of electrical power at the generator house—$18.00 per year. Assuming a loss of 10 per cent. in transmission and distribution, the cost of power would become $20.00, exclusive of capital charges on the transmission and distributing lines, transformers, etc., depreciation on the same, cost of maintenance, superintendence, management, etc. With these items included, the final cost would not be much below the cost of steam power generated in large quantities at the Buffalo lake front. As there are, however, few or no plants in Buffalo using power in such large quantities as to involve the latter consideration, the price at which electrical power could be delivered under the terms offered would therefore result in a very considerable saving over steam power. The position of the Niagara Company in refusing to consider the acceptance of any franchise fixing a maximum or any other price at which power is to be sold, is well founded and cannot reasonably be objected to in the interests of power users. The cost of steam power varies within such wide limits, depending upon the quantity in which it is generated, that any fixed maximum price would be an arbitrary figure, and very unequally affect different users. As stated by the company, those who wish to buy electric power will only do so because of its being more economical than their present source of power, and the making of the bargain should therefore be left, as in other business matters, with the private interests involved. Should the municipal authorities consider that the public ought to receive a return for the franchise to be enjoyed by the distributing company, the charges for this should be so placed that the entire public and not merely the users of power will be benefited, and the company thus left free to negotiate with the latter on a purely business basis. The results given of tests of large steam plants are interesting, and that of the Buffalo plant, recently thoroughly investigated by a competent expert, confirms the figures by Mr. C. E. Emery, it having been found that the annual cost of a horse power was $32.70 on a basis of 11 hours per day and a quantity of over 1,000 horse power. The prices given of power at pumping stations are in surprising contrast to the claims usually made, and offer a sigificant commentary upon engine tests in general as made by "disinterested" experts in this country.

MEASURING ILLUMINATION.

Of all the factors connected with the practical applications of electricity, that relating to the measurement of light is the most unsatisfactory. One cause of this has been that heretofore such measurements have been confined to the source of light, which has been unsatisfactory for several reasons. What is desired to know is the lighting effect at given surfaces, and this can only be indirectly determined by measurements of the source of light, and then not in a very satisfactory manner. With incandescent lighting it has been necessary either to resort to inconvenient calculations or to roughly estimate the effect of a given distribution of light by trial. With arc lighting it has been still more unsatisfactory, on account of the variable distribution and the differences in the intensity of the rays from an arc lamp; the direct measurement of this source is ordinarily so complicated as to be impracticable, and consequently the user has had no means of learning that he was receiving the light paid for, while the company has been unable to know if the carbons used were or were not giving within 50 per cent. of the light to be expected from the energy supplied. If we were able to measure the illumination at a surface, then lighting would at once assume a scientific condition and the selection of proper arc carbons would be a matter of no difficulty, instead of one of mere guesswork, as at present. To accomplish these most desired ends a simple and practicable apparatus for measuring illumination is desired, and therefore the announcement of such an instrument at the Cleveland Convention was an important feature of that meeting. In other columns we print the paper of Messrs. Houston and Kennelly on "A New Method of Measuring Illumination," which contains a description of an illuminometer extremely simple in its details and operation. As will be seen, the apparatus rests upon the physiological principle that a certain intensity of illumination is required to render a definite object, viewed at a definite distance, just legible. While it is granted that the eyes of different persons may vary as to the limit of legibility, it is asserted that this range will not introduce an error greater than 10 per cent., which will not militate against the use of the apparatus for practical purposes. The objection urged against the instrument proposed, through errors that may be introduced by the imperfection of the human eye and different qualities of light, would seem to apply to any form of apparatus involving the use of the eye and a comparison with a fixed standard of illumination. Another source of error noted is that arising from familiarity with the test characters, thus rendering them more easily distinguished; this may be valid as concerns a new observer, but after some experience with the instrument an intelligent man should be able to largely or entirely eliminate this factor, though, we confess, it might not be so easy for one of small intelligence not able to prevent ulterior considerations from affecting the judgment of his faculties. After all, the only valid criticism will be that based upon actual experiment with the instrument, and every one will strongly hope that the great promise it holds forth may be most fully realized.

The Bate Refrigerating Case.

The decision of the United States Supreme Court in the case of the Bate Refrigerating Company vs. Ferdinand Sulzberger et al, was handed down on March 3, and sustains the view of the lower courts that the date of issue and not the date of application shall prevail in applying to a domestic patent the limitation as to life through the expiration of a foreign patent. The opinion was written by Judge Harlan and the decision was unanimously supported by the Court.

Judge Harlan in setting forth the positions of the parties in the suit says the plaintiff insists that, under a proper construction of the statute, an invention, patented or caused to be patented in a foreign country before being patented in this country, should not be deemed to have been "previously patented in a foreign country," unless the foreign patent was issued prior to the application for the American patent. The defendants contend that the respective dates of the American and foreign patents, and not the date of the American application, determine the question whether an invention, patented here, has been "previously patented in a foreign country."

The history of legislation relating to patents is given fully in the opinion with citations from the several statutes. From this history it appeared to the Court that Congress had always in mind the date of an application for a patent, the date of the filing of specifications, and the date of the patent.

Under the act of 1836, a patent could not be granted if it appeared that the applicant was not the original and first inventor or discoverer, or that any part of that which was claimed as new had before been invented or discovered or patented or described in any foreign publication in use in this or any foreign country; yet, an original and true inventor was not to be deprived of a patent for his invention "by reason of his having previously taken out letters patent therefor in a foreign country, and the same having been published at any time within six months next preceding the filing of his specifications and drawings."

Under the act of 1839, an inventor, whose invention had not been introduced into public and common use in the United States prior to the application for a patent, should not be debarred from receiving a patent, by reason of his invention "having been patented in a foreign country within six months prior to his application."

Under the act of 1870, an inventor whose invention had not been introduced into public use in the United States for more than two years prior to the application should not be debarred from receiving a patent by reason of its having been first patented or caused to be patented in a foreign country—these words not being qualified, as in the act of 1839, by any reference to the date of the application.

When an American patent was granted, in conformity with the sixth section of the act of 1839, for an invention "patented in a foreign country more than six months prior to his application," it expired, in every case, at the end of fourteen years "from the date or publication of such foreign letters patent;" and when, in conformity with the twenty-fifth section of the act of 1870, a patent was granted for an invention "first patented or caused to be patented in a foreign country," it expired "at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term."

Under the Revised Statutes, while a patent for an invention can not be withheld nor deemed invalid "by reason of its having been first patented or caused to be patented in a foreign country, unless the same has been introduced into public use in the United States more than two years prior to the application," yet "every patent granted for an invention previously patented in a foreign country shall be so limited as to expire at the same time" with the one having the shortest term, in no case to remain in force longer than seventeen years.

After an elaborate review of previous decisions, the Court says that it is of opinion that Congress intended, by the twenty-fifth section of the act of 1870, preserved in Section 4,887 of the Revised Statutes, to introduce a new test in respect of the term of an American patent where the same invention was the subject of a foreign patent first issued. It has already been observed that the statutes relating to patents show upon their face that Congress always had in mind the difference between an application for a patent and the patent itself. And that difference is apparent in the act of 1870.

The Court says it cannot superadd, in Section 4,887 of the Revised Statutes, the words "prior to the application" either after the words "first patented or caused to be patented in a foreign country," or after the words "previously patented in a foreign country" without defeating the intention of Congress as manifested by the language it selected to indicate its purpose. And the express command of the existing statute is that every American patent for an invention "previously patented in a foreign country," that is, "first patented or caused to be patented in a foreign country," shall expire at the same time with the foreign patent. No words are used that will justify the Court in holding that an invention patented in a foreign country before being patented here is to be exempt from the operation of the provision limiting the term of the American patent to expire with the foreign patent.

Referring to what has been said about the intention of Congress, as manifested by its legislation, to deal liberally with inventors, especially those who were citizens of the United States, the Court says that while this is true, it is for Congress to prescribe the conditions upon which it will secure to inventors the exclusive right to their inventions. What may be due to inventors is a matter about which there may well exist differences of opinion. It is the province of the legislative branch of the Government to say when a patent to an inventor shall expire, and, therefore, when the public may enjoy, without charge, the benefit of the invention covered by it. It can be very well understood how the existing statute may, in circumstances, operate injuriously to an American inventor, who, in addition to the exclusive rights granted to him in this country for the term of seventeen years, wishes to secure a monopoly for his invention in other countries; for, if he obtains foreign patents for his invention before obtaining one here, the American patent is limited by law, whether it is so expressed or not in the patent itself, to expire with the foreign patent having the shortest term. This is the case as it appears from the standpoint of the patentee, without regard to the interests of the American public.

In conclusion the opinion holds that it must be presumed that the Revised Statutes of 1874 were adopted with the knowledge on the part of Congress of the construction previously placed by the Patent Office upon the twenty-fifth section of the act of 1870. This presumption is strengthened by an examination of the act approved Feb. 18, 1875, entitled "An act to correct errors and to supply omissions in the Revised Statutes." That act, upon its face, shows that the entire revision of 1874 was carefully re-examined, after it was adopted, for the purpose of ascertaining whether errors or omissions in the work of revision had been committed. Now it is inconceivable that the difference in the wording of the twenty-fifth section of the act of 1870, or of section 4,887 of the Revised Statutes, when compared with the act of 1839, could have escaped the attention of Congress, especially as the act of 1870 had been interpreted as introducing a new rule in respect of the term of an American patent, where the same invention was covered by a foreign patent previously issued. The act of 1875, for the purpose of correcting errors and omissions, amends nearly seventy sections of the Revised Statutes. But there was no alteration of Section 4,887.

The rule prescribed by the twenty-fifth section of the act of 1870 having been reproduced in Section 4,887 of the Revised Statutes, and the latter section never having been amended, the Court states that it ought not, after the lapse of nearly twenty-five years from the passage of the act of 1870, place upon its twenty-fifth section, or upon Section 4,887 of the Revised Statutes which took its place, any interpretation other than that which the ordinary natural meaning of their words impart.

The decision of the Court in its answers to the questions certified is that the invention for which a United States patent to Bate was issued was, under the facts stated, "previously patented in a foreign country," within the meaning of these words in Section 4,887 of the Revised Statutes, and that the United States patent to him expired, under the terms of that section, before the expiration of seventeen years from its date.

Meeting of the American Institute of Electrical Engineers.

At the meeting of the American Institute of Electrical Engineers held at 12 West Thirty-first street, Wednesday evening, February 27, Mr. H. Ward Leonard presented a paper entitled "Notes on Recent Electrical Development in France and England." Mr. Leonard considers that we are rapidly losing the lead in the electrical field which we have thus far held, and this he ascribes to the effect of so-called fundamental patents and the result of enormous aggregations of capital and engineering forces under one management. He thinks that the practical development of electrical engineering is almost impossible because of these gigantic corporations, in that they have such a large proportion of capital represented by patents, the value of which they do not wish to have destroyed by improvements which they do not control, and which they therefore depreciate.

Mr. Leonard states that in his opinion we have no alternating

central station or electric railway system in this country which is a credit to the profession. He condemns our present alternating distribution practice and commends the foreign use of the three-wire secondary with 100 volts on each side. The foreign practice of placing in the hands of consulting electrical engineers the design of large plants is highly spoken of, as well as the employment of rotary transformers in connection with continuous current stations for the supply of distant territory.

The Parsons and Laval steam turbines are described and a reference made to the Newcastle-on-Tyne central station, where 25,000 lights have been operated solely from the former since 1890 with good financial results. In this station all the conductors are of vulcanized rubber cables drawn through gas and water-tight cast-iron underground pipes, through which chemically dried air is forced by a blower. There are six miles of piping and over 25 miles of cable, and in the five years of the operation of the plant there has not been a single instance of failure of operation, of an explosion, or of other trouble. The simplicity of the steam turbine is dwelt upon and Mr. Leonard thinks that this type of motor is likely to become an important factor in the electrical field, while the design of a dynamo for use with it offers an opportunity for the ingenuity of inventors. Several London central stations are described, one of which uses four 350-kw Parsons turbines running at 3,000 revolutions per minute. These also give great satisfaction, being accompanied by no vibration, and working at an economy equal to that of the compound-condensing reciprocating engines which they displaced. The absence in England of electric motor services and the poor design of switchboards are referred to.

A French substation with a capacity of 30,000 lights is described. This is supplied from a distant central station with a constant current of 250 amperes, all devices being in series, the total E. M. F. running as high as 6,000 volts at times. Power is furnished thereby through rotary transformers to feed a five-wire system of conductors at 110 volts. The station also includes a storage battery plant with a capacity of 24,000 10-cp lamp hours. The price of this battery was $107 per kw-hour of output. Mr. Leonard does not deem this to be an economical adjunct, and says that the craze for storage batteries for central stations seems to be on the wane in Europe.

In France Mr. Leonard examined the Heilmann locomotive, which he pronounces the most important electrical engineering development of all he saw abroad. Among its advantages are the greater efficiency of the boiler and engine in use with it over that of the locomotive boiler and engine, the greater control over the tractive power, and the less destructive effect on the roadbed of the "hammer blow" and side thrust. He says that a locomotive of this type would be able to pull 50 per cent. more weight than the present steam locomotive, and could pull the same weight at 50 per cent. higher speed. The remarks of Mr. Leonard on the importance of the load factor in central stations are reprinted in full elsewhere. The paper was discussed by Messrs. Townsend Wolcott, J. W. Lieb, Jr., C. E. Emery, Herbert Lloyd, A. E. Kennelly, Wm. Maver, Jr., M. W. Forney, Cary T. Hutchinson, Richard Fleming, Joseph Sachs, Profs. F. B. Crocker and E. J. Houston.

At the regular monthly meeting of the council on the same date it was voted that the general meeting of the institute be held at Niagara Falls, beginning June 18. It is proposed to devote this meeting principally to the question of power transmission.

A Straight-Line Accumulator Characteristic.

BY CARL HERING.

In plotting the results of a recent set of accumulator tests, a number of different curves were obtained, depending on the choice of the quantities used as co-ordinates, one of which, and a very important one, was found to be practically a straight line. Not having seen this result published before, I thought it might be new and of interest to those working with accumulators, as it enables one to find by a very simple calculation the capacities for different rates of discharge. The result will probably be different for different types of accumulators, and each maker will therefore have to determine for his particular type of cell whether this relation is a straight line function, and if not, then whether it approximates sufficiently close to it for the calculations occurring in practice. It should be stated here that this accumulator differed somewhat from the usual types, it being specially suited for rapid discharges.

In the tests referred to, the same cell was fully charged for each test, and was then discharged at each of a number of different rates, from a very rapid to a very slow one, the discharge being considered ended when the difference of potential had fallen a certain fixed percentage of that at a few minutes after the beginning; the current was kept constant by adjusting the external resistance. As the cell was intended for power purposes it would have been more correct to have kept the watts constant instead of the current, but this involves difficulties, besides introduces errors; the differences in the results are probably quite negligible.

The curve usually constructed is the one connecting the capacity with the *time* of discharge, but as this is far from being a straight line it is at first sight discouraging to try to reduce it to a convenient formula for calculations. But if instead of making the abscissas represent the *time*, they are made to show the rates in *watts*, the ordinates being the capacities in *watt hours*, then the curve for this particular cell approximated within 2 per cent. to a straight line having the general form:

$$\text{watt hours} = a - b \text{ watts},$$

the values of the constants for this particular accumulator being $a=228$. and $b=.272$ (or $\frac{3}{11}$). This enables the output for any particular rate of discharge to be calculated very easily, and as the results were obtained between a very rapid and a relatively slow discharge, they include practically all the cases occurring in practice.

For a theoretically perfect accumulator, having a constant capacity and no internal resistance, this line should not only be straight but also horizontal. The inclination of this line, therefore, also shows how nearly it approaches to the theoretically perfect conditions.

From the above equation it is also very easy to calculate how long the discharge will continue at any desired rate in watts, even though the curve connecting the watts and the time is by no means a straight line. Dividing by the watts gives

$$\text{time in hours} = \frac{a}{\text{watts}} - b.$$

The curve connecting the capacity in ampere hours with the rate in amperes is somewhat similar, but for this accumulator it is not so close an approximation to a straight line; perhaps it may be for other types, but if it is not, it may be sufficiently so for many practical purposes.

As it is often required to know the capacity at a certain rate, or perhaps the rate for a certain capacity or time, the above simple relation may be of use to those working with accumulators. The desired information can, of course, be obtained even without calculation from the curve itself, but it may often happen that the curve is not at hand while the constants are easily remembered or noted.

The constants must, of course, be determined for each type of cell, as they will probably differ considerably, depending mainly on the thickness of the active material, and on its porosity.

Importance of the Load Factor in Central Stations.*

BY H. WARD LEONARD.

All central station people have known for years that the most profitable consumers were those who used their lamps for the greatest number of hours.

In other words, that the net profit due to a consumer was largely dependent upon the relation between his average load and his maximum load, which Mr. Crompton in England has aptly called the "load factor." Yet, while appreciating this fact, central station companies make their rates dependent upon the kilowatt hours used, and independent of the maximum kilowatts used.

Mr. Arthur Wright, at Brighton in England, deserves the credit, as far as I know, for having first given commercial recognition to this load factor of the consumer. Mr. Wright supplies each consumer not only with a meter which registers the kilowatt hours used, but also a second meter of simple construction which registers the maximum kilowatts used at any time during the month, and the discount which the consumer gets is very largely due to the relation between his average and his maximum kilowatts.

Suppose that there are two customers connected to a central station and that the monthly readings show that each has used 900 kilowatt hours. By the usual practice in this country the bill would be the same, yet one bill may be due to the use of one and one-quarter kilowatts for 24 hours per day, and for 30 days per month, and the second bill may be due to the use of 30 kilowatts, an average of one hour per day for 30 days per month. That is, the first bill may be due to a steady load, such as a few lamps in a basement

* Extracted from a paper read before the February meeting of the American Institute of Electrical Engineers.

of a hotel or a ventilating fan, while the second bill may be due to a larger load of lamps used only occasionally, as in an office building or an electric elevator requiring 30 kw for a few seconds to start it up, and after starting requiring only 15 kw.

With the same 900 kw hours per month for the two cases, the central station company should charge at least five times as much for the case having the elevator and small load factor as in the other case.

It is a fact not generally appreciated that in any central station the cost of producing a kilowatt hour can be divided into two portions, one of which, such as interest on cost, depreciation, salaries, a small part of the labor and coal, vary with the kilowatt capacity of the plant, that is proportionately to the maximum load, and are independent of the number of kilowatt hours produced, and the other portion of the cost of producing 1 kw hour represented by the larger portion of the coal, labor, water, etc., is dependent upon the number of kilowatt hours produced, and is independent of the maximum load.

The fact about this matter which is least appreciated is, that the portion of the total cost of 1 kw-hour produced, which depends upon the maximum load, is about two-thirds of the total cost, and the part dependent upon the output is only about one-third.

In a modern central station 1 kw of its capacity represents about $300 invested. Consider the two consumers cited above. Both loads are in use at the time of maximum daily load. For the elevator, the central station has to provide an investment of $9,000, for the ventilating fan $375. Assuming interest, depreciation and similar charges, at 10 per cent. we have $900 to deduct from our gross earnings in the elevator case before we reach net profits, and $37.50 in the other case.

Suppose we get 10 cents per kilowatt hour in each case, and that the cost of production, independent of general expenses, interest, depreciation, etc., is 50 per cent. of the gross receipts, etc. This would mean that if we get 10 cents for each kilowatt hour in both cases our gross revenue would be $90 per month in each case and our gross profit $45 per month, or $540 per year in each case. But in the elevator case we have interest and depreciation charges of $900 a year, and hence have actually lost considerable money in supplying this customer, while in the other case we have made a net profit of over $500 per annum.

We would have to charge more than ten times the rate per kilowatt hour to the elevator that we charge to the ventilating fan to make the same net profit on $1 of capital invested.

This load factor is a most vital question, and it is the difference in load factors in English and American central stations which makes storage batteries commercially possible there and impossible here.

The average load factor of an English central station is less than 15 per cent., and even in London in December it is only 33 per cent., while in most American cities the load factor, which averages 40 per cent., will, in December, in many cases, be above 50 per cent.

This difference is due almost wholly to our motor load, which is an almost unknown quantity abroad. With a 15 per cent. load factor a storage battery may pay, but not with a load factor of 40 per cent., especially when the load factor in our central stations is rising each year.

If central station companies would offer such a discount due to load factor as to warrant an individual customer's installing at his own expense a storage plant which he would charge at the minimum rate per kilowatt hour by a steady current for 24 hours per day, and then used this stored energy to supply his occasional demands of an occasionally very large rate of energy, I believe it is possible that the central station companies, the storage battery companies and the consumers might all derive a profit from the arrangement. I have no doubt that a central station company could afford to make a rate of four cents per kilowatt hour for a continuous service night and day, and make a satisfactory profit, while it would surely lose money in supplying an elevator, such as described above, at even 15 cents per kilowatt hour.

I believe that the following schedule of rates fairly represents the charges per kilowatt hour that should be made to customers of various load factors.

It must be noticed that this argument would lose most of its force if the maximum load of the consumer did not occur at the time of day when the maximum load was upon the central station; but in elevators, and similar loads which call for their maximum load in starting up every few seconds, the maximum loads will not only occur together occasionally, but this will sometimes occur at the time of maximum load on the central station, and when this accumulated load is put upon the central station, the kilowatts must be there to meet the demand.

Load Factor.	Rate per kw hour in cents.	Resultant Gross Income per annum per kw of plant.
5	30	$131.40
10	20	175.20
15	16	210.24
20	13	227.76
25	11.2	245.28
30	10	262.80
35	9.2	281.07
40	8.5	297.84
50	7	306 60
60	6	315.36
70	5.3	325.00
80	4.8	336.38
90	4.4	346.89
100	4	350.40

Electrical Transmission from Niagara to Buffalo.

A meeting was held Feb. 21, at Buffalo, between Secretary W. B. Rankin, of the Niagara Falls Power Company, and a committee of Buffalo municipal representatives, at which Mr. Rankin presented for consideration a statement of the views of his company with respect to the transmission of electrical power from Niagara to Buffalo.

The application made by the Niagara Falls Power Company as to transmitting to and distribution in Buffalo 10,000 hp generated in its power house at Niagara Falls was stated to be necessary as a basis for a decision. To be ready to do this will involve the extension of the present wheel pit by at least 140 feet, and the installation of three 5,000-hp turbines and three 5,000-hp dynamos in addition to those already ordered and partly installed (one being a reserve); also, the building of transformers, transmission lines and a distributing system. The company is advised that such extension of wheel pit and the necessary hydraulic and electrical installation can be made within eight months from the ime the order is given for the work and plant. Before the order is given it is necessary, therefore, for the company to know, and at an early day, what action the city of Buffalo will take in regard to a franchise.

The power company has found that it cannot economically transmit to Buffalo less than 10,000 hp, and it cannot consider the transmission of any less amount. If a proper franchise be granted, the company is prepared to institute the arrangements necessary to effect the proposed transmission and distribution of 10,000 electrical horse power generated at Niagara.

While the company recognizes the propriety of provisions for the protection of property and the public safety, there have been suggested some restrictions which, if incorporated in the franchise, will absolutely prevent its acceptance by the company.

First—The company cannot accept a time-limit less than the term of its bonds. Such a restriction would deprive the company of any proper or usual basis for estimating the propriety, security or extent of its proposed investment; and

Second—The company cannot consent to the fixing of a maximum or other price for power within the city. The price must be left as a matter of negotiation in each instance between the company and the taker of the power, who will find adequate protection in the fact that unless the electrical power can be used at a cost below that of steam power it will not be used. The company will be prepared to sell, and can sell, power in Buffalo to those who wish to buy it, only because they find it more economical than any other power.

As to the city purchasing the power from the company at Niagara, the company is now ready to execute a contract in either one of three forms for the sale to the City of Buffalo of 10,000 hp, deliverable on the lands of the company at Niagara, upon the following terms and at the following prices:

First—10,000 hp undeveloped on lands of the company at Niagara at $10 per hp per annum, 24-hour power; the City of Buffalo to make its own wheel pits and side tunnels and to put in its own wheels. The necessary water, the inlets and the necessary discharge space in the completed tunnel of the company are now ready to produce this power. This form of contract is of public record at Lockport with the Niagara Falls Paper Company, by whom this form of power has been in satisfactory use for over one year, showing that interruptions from ice or other causes are not to be feared.

Second—Or 10,000 hp developed on the shaft of turbines furnished

by the company on the company's lands at Niagara, at $13 per hp per annum, 24-hour power; so to be delivered within six months from the execution of the contract.

Third—Or 10,000 electrical horse power, alternating current, at a voltage of 2,000 as it comes from the company's generators at the power house, 24-hour power, at $18 per horse power per annum, to be delivered within eight months from the execution of the contract.

In the event of the city making a contract for power in either of the above forms the company will place at its disposal all the data which it has gathered in a five-years' study of the problems of transmission, and will arrange for a satisfactory use by the city of the rights of way between Niagara Falls and Buffalo which the company has acquired. These rights of way are three in number and are practically complete.

The company cannot name a price for electrical power transmitted to the Buffalo city line, as in the question of transmission are involved the uncertainties of the losses and cost of operation and maintenance.

The company has made a contract with a large electrical power user for not less than $20,000 per annum for 1,000 electrical hp delivered on the company's land in Niagara. As this statement has been called in question, the company offered to submit this contract to the inspection of the Mayor of the City of Buffalo.

Referring to the tabulated statement said to have been prepared by Mr. Richard Hammond and recently published in the Buffalo *Courier*, showing the cost of 1,000 hp ten hours per day to be $21 per horse power per annum, the company is prepared to prove that for the city of Buffalo and under the conditions assumed in that statement, the annual cost of such 10-hour power is not less than $32. If there were any plants existing under the same conditions and of the other sizes mentioned in the publication, the discrepancy between the figures estimated for the larger units and the actual figures would be even greater.

With a determination to avoid all arbitrary estimates, consideration has been given to actual facts and actual conditions in the cities hereafter mentioned, and the following figures are submitted, which the company considers as indisputable:

A recent test by a disinterested expert of the cost of steam power, ranging over a period of 18 months, in a Buffalo plant using considerably over 1,000 hp under excellent condition as to economy, shows the annual cost of such 11-hour power to be $32.70.

At the Buffalo City Water Works, with engine capacity of 3,600 hp, the average cost of all the engines in use for the years 1893 and 1894, as stated by their engineer, for over 2,000 hp, is $77.55, and Mr. Knapp estimates that for 1895 the cost of 3,000 hp will be over $60; this is pump horse power, and the average efficiency of the engines having been found to be 80 per cent., the average cost of the steam horse power of the pumping engines for the years 1893 and 1894 is $62.04.

In Milwaukee, Wis., as the result of a year's work at the North Point plant of the city's water works with steam pumping engines of 500 hp (a plant which Prof. R. H. Thurston, the recognized American authority on the cost of steam power, pronounces one of the most economical steam plants in existence), a careful examination shows the cost of pump horse power to be $75.83, and for steam power to be $68.25, and this exclusive of any allowance for insurance and taxes.

In Urban & Company's flouring mill in Buffalo, a recent expert test of a 400-hp plant covering the year 1894, shows the cost of this 24-hour power to be not less than $45.

Mr. Huntley, the general manager of the General Electric Company, of Buffalo, states that it is safe to say that in nearly every factory in the city the cost of steam power is not less than $45 to $60.

If the city does not desire to purchase power at Niagara, as above suggested, then, within the limits and to the extent above stated, but not otherwise, the Niagara Falls Power Company renews its application for a franchise in the city of Buffalo.

After reading the statement given above, in reply to questions Mr. Rankin said that the time limit referred to, dependent upon the duration of its 50 per cent. bonds, was for 40 years from 1892. He also said that there would be no difficulty in furnishing Buffalo with any amount of power up to 30,000 hp, and that after the first 10,000 hp it could be sent in blocks of 5,000 hp. The company has contracted to furnish over 10,000 hp upon call, and most of this is to be furnished as soon as the company is ready to supply it. He also said that if Buffalo wanted more than from 30,000 to 50,000 hp the Niagara Company would probably build another tunnel.

The Monocyclic System.

BY DR. LOUIS BELL.

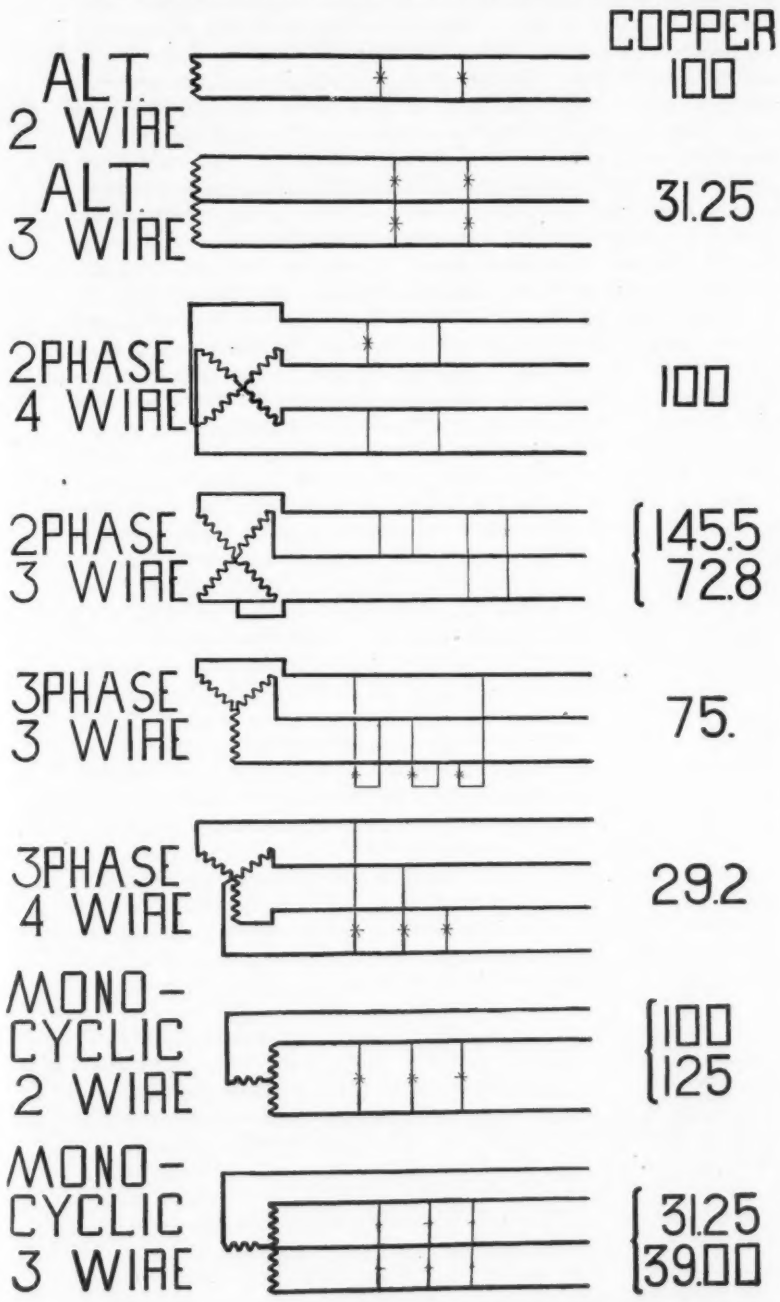
To the central station man no recent change in engineering practice can have more interest than the renaissance of alternating current work which is now in progress. Truth to tell, until quite recently the alternating current was somewhat under a cloud in the estimation of both station managers and engineers. It had served an immensely useful purpose in the extension of electric lighting to places where it would have been utterly impracticable to install a direct current system of any sort, on account of the scattered nature of the work. A very large number of stations have been installed on the alternating system, and I am sorry to say that a large proportion of them have been somewhat unsatisfactory, not in their general operation, but in the character of their service and the commercial results. It is quite common to find alternating stations with a plant efficiency considerably below 50 per cent., and in which the regulation is maintained only within, perhaps, about 10 per cent. Under these circumstances, it is small wonder that the advocates of the direct current, the uses of which as an engineering problem have been very completely worked out, have been often somewhat violent in their animadversions on alternating currents in general. Nevertheless, in the last two or three years there has been a vast change for the better in alternating practice; a change not yet rapid, but bidding fair to be far-reaching. This change has taken up a three-fold path toward progress:

First, the use of large transformers is becoming more frequent. Next, these transformers are more and more used in conjunction with systems of secondary mains; and, finally, it is now possible to install an alternating plant that shall be able to operate motors as successfully as can be done with direct current. In ordinary central station practice the motor service does not usually play a very important part; nevertheless, the ability to run motors is most valuable. It is more profitable, speaking broadly, to sell current for light, for a better price per kilowatt hour can be obtained; at the same time, if motors can be readily furnished, a useful day load can be obtained when it is needed, and the plant becomes of greater service to the community, a thing which, in these days of more or less friction with common councils, is of no small importance. Not only can motors now be successfully worked off alternating circuits, but off a wide variety of such circuits. As yet, however, there is no successful motor for use on the simple alternating system, which has, for the most part, been installed in this country. While it is possible to construct a single-phase motor even for 120 to 130 cycles per second, the frequency most used in America, it is at present very doubtful whether such a motor can be made to start and run in a way which will be generally satisfactory. Abroad, where low periodicities are used, better results may be obtained, but, even there, there is a noticeable silence on several important points in describing alternating motor practice. Appearances indicate that even with the advantage of low frequency, motors for use on simple alternating circuits still start badly, and particularly require enormous currents at the moment of starting; hence the growth of various modified alternating systems, of which the polyphase are the best known, by the use of which it becomes possible to avoid this difficulty entirely and to work alternating current motors in every respect as satisfactory as those operated by direct current.

The polyphase motor has solved the problem of securing good motor service with alternating currents in a very complete manner, although at the cost of slight complications which, while generally overestimated, are, nevertheless, distasteful to central station men, especially where the use of such a system would involve an extensive and costly re-arrangement of the distribution service. It is the purpose of this paper to call your attention to the various methods of central station distribution, involving motor service on the alternating current system, and more especially to a modified single-phase alternating system which lends itself very readily to a very simple and straightforward distribution for lighting without sacrificing the excellent motor service which makes the true polyphase systems so desirable. For all-around central station work, the lighting service is of most fundamental importance, and convenience and economy in this particular must, in a vast majority of cases, be the first consideration. Fig. 1 shows in a diagrammatic manner the general arrangement of various alternating circuits, including those already familiar and the polyphase and monocyclic systems. First in order, both of time and extended use, comes the simple alternating system, single phase, with an ordinary two-wire distributing circuit. In operating the secondaries of such a system,

we run immediately into limitations imposed by the feasible voltage for lamps, limitations which have acted as a brake on alternating current work, and which are responsible for a good many difficulties in the operation of alternating plants. Opposite the diagram of this circuit is placed the relative amount of copper required for lighting with such a distribution.

Next comes the alternating circuit modified for Edison three-wire distribution, which is so familiar in its character that it needs no description here. The amount of copper needed, on the supposition that neutral is half the size of either of the others, is, of course, enormously reduced, amounting, as you see, to less than one-third of that needed with the two-wire system; consequently, the secondary main distribution, so important to economical operation, can



DIAGRAMS REPRESENTING ALTERNATING SYSTEMS.

be carried out with the greatest facility. We are justified, at present, in saying that neither of these systems lend themselves to the ready operation of motors.

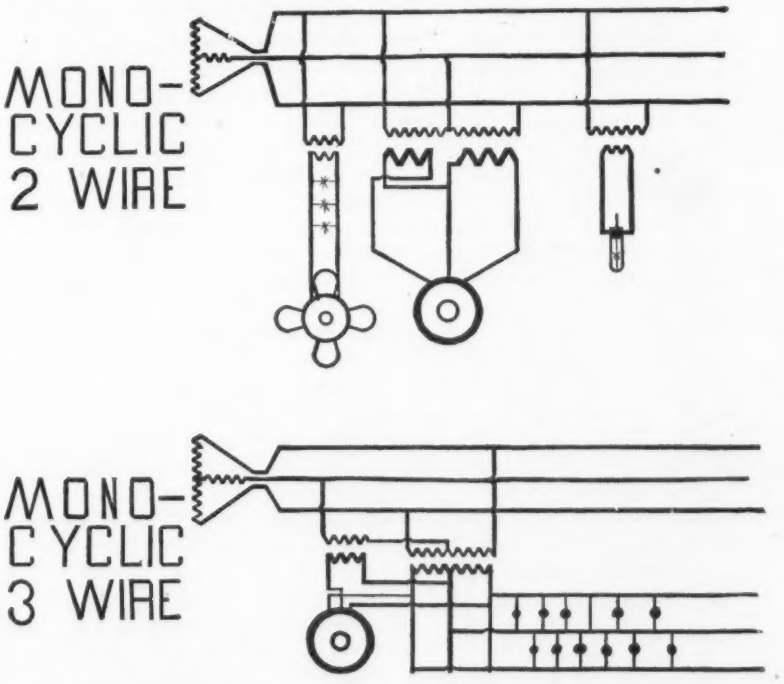
We may next consider the two-phase alternating system worked with four wires, giving, if desired, two separate circuits for each machine. The copper here required is the same as that used with the single phase, and so long as the four wires are kept together motors can be freely operated. Here is assuredly a step in advance. The operation of two separate circuits, however, from a single machine, involves certain complications. In the first place, unless the circuits are balanced as to load, the operation of the system is somewhat difficult to make satisfactory in point of regulation. The circuits themselves have absolutely no influence on each other, but they are derived from the same machine, and with a given excitation of that machine, unless the loss in the two circuits is the same, the voltage must necessarily be different, consequently the generator cannot be compounded for both circuits unless the circuits are balanced. There are three ways out of this difficulty; none of them, unfortunately, is altogether unobjectionable.

In the first place, one can make the loss on the line so small that the difference in voltage, due to any reasonable difference in load, is of no moment. This can sometimes successfully be done, but more often it involves a very unnecessary cost for copper, and even at its best is likely to give regulation which, although better than that found on most simple alternating systems, is yet not good enough to suit the requirements of the best modern engineering.

Second, the machine can be compounded for loss on one of the lines, a feeder regulator being used on the other. This practically means hand regulation of one circuit.

Or, finally, both circuits can be operated by such regulators. In any case, if motors are to be operated, the two-phase must be interlinked at least by one wire.

A somewhat simpler two-phase distribution is that shown in Fig. 2, where the two phases unite into a common three-wire circuit. The amount of copper here required differs very materially according to the limitations of voltage that one chooses to fix. If the maximum voltage of the system is limited to the same maximum voltage used on the single-phase two-wire or two-phase four-wire system, the amount of copper required is very largely increased by the use of the third wire, owing to the fact that the two circuits combined are out of phase with each other by 90 degrees. The relative amount of copper required here is, as you see, 145.5. If, on the other hand, the question of maximum voltage between wires is neglected, and the voltage is determined by the use of lamps of the same voltages as on the other systems, then the amount of copper is materially reduced, being a trifle less than three-fourths of that required on the systems before mentioned. In this case we neglect the fact of there being an excessive voltage between the outside wires, and connect lamps between the middle wire and the two



outside ones, much in the manner of an Edison three-wire system, with the exception, of course, that the saving in copper is not anything like the same amount. Such a system allows the distribution of the whole load for lights and power in a single circuit containing only three wires. It therefore avoids the difficulty of regulating two separate circuits. On the other hand, it causes a new and very curious difficulty, owing to the fact that the two combined phases are unsymmetrical with regards to the inductance of the system. The voltages between the middle wire and the two outside wires are unequal, when the systems are equally loaded, by an amount depending on the inductive loss on the line. Consequently, when in balance for regulation, the system is unbalanced as regards the load on the two sides, a condition which, although it may not

lead to trouble in some cases, is still a menace to the successful operation of the system, unless the distribution be skillfully engineered. There is, however, the possibility of a noticeable saving in copper.

We may next pass to the three-phase alternating system. The system which corresponds to the two-phase four-wire system will not be considered, as the use of three separate circuits would be even more troublesome than that of two, and would have no compensating advantages. The ordinary three-phase circuit is that shown in the figure, wherein the three phases are united into three wires and taken everywhere where the motors and lights are wanted. In this case, for the same voltage between wires, the amount of copper demanded is just three-fourths of that demanded for a single-phase two-wire or two-phase four-wire circuit. To compensate for this, there is the possibility of unequal voltages in case the three legs of the circuit are unequally loaded, owing to interaction in transformers and in the generator. So far as inductance on the line is concerned, the system is symmetrical and balanced.

If the load on the three branches is very unequal, as, for example, if one branch is entirely unloaded or very lightly loaded, while the other two are worked to their full capacity, there will be a perceptible unbalancing of the voltage. Experience, however, shows that with anything like the same care in balancing that would apply to an Edison three-wire system, this theoretical difficulty of balance is absolutely negligible. I say this advisedly, as the question has been so often raised that I have taken pains to investigate the conditions in three plants operating lights with reference to this particular thing, and the statement just made is the result of actual practice. It might be thought at first sight that good results could be obtained by combining with either a two-phase or three-phase system the Edison three-wire distribution. As a matter of fact, such a system would be unreasonably complicated with either two or three phases, as any central station man will readily appreciate, inasmuch as it would be necessary to have two or three-wire systems, each balanced, and mutually balanced with respect to each other, covering the territory if motors are to be run, or at least interlinked in a somewhat complicated way.

There is, however, a three-phase system which does secure a very great advantage in copper. This is the three-phase four-wire system shown in the figure. It consists of the ordinary three wires employed on the three-phase system, with the addition of a balance wire proceeding from the common connection of the generator or the transformer and forming a part of the general distribution system. The lights are, as can be seen from the figure, connected between either of the three-phase wires and the balance wire. Between each of the outside wires there are, therefore, what may be considered two lamps in series, having, however, a phase difference of 120 degrees. The voltage of transmission, then, between each of the three main wires, is 1.73 times the voltage employed in the lamp connected, nearly 200 volts for 110 volt lamps. This necessarily means a large saving in copper, which is still further enhanced by the fact that the three-phase three-wire system requires intrinsically only 75 per cent. of the copper used on the single phase or direct current system. The total result with this particular connection is but 29½ per cent. of the copper required on the single-phase system, supposing, as in the Edison three-wire distribution, the neutral wire to be half the size of either of the others. Such a system is in successful use at St. Hyacinthe, Canada, in connection with long secondary mains. The price paid for this saving in copper is the introduction of a fourth wire into the distributing system.

Comparing, then, the lighting distributions on the two and three-phase systems, we find that if three wires only are used, both save very nearly the same amount of copper. The extreme voltage between wires on the two-phase circuit is, however, considerably greater, and both are liable, but not likely, to become unbalanced.

There is this difference, however, that if we are to balance a three-phase system in respect to voltage, we need only to see that the load is unequally distributed between the three branches. If we are to balance a two-phase, three-wire system, we must see that this load is unequally distributed between the three branches by an amount depending on the inductance of the line. We therefore see, comparing the polyphase with the single-phase system, that the price we have to pay for the privilege of successfully operating motors is a certain amount of complication in circuits, which, while not of great importance in new installations, hinders the ready adaptation of a polyphase system in a plant having already a large number of circuits installed. Attractive as the single-phase is in its beautiful simplicity of wiring, we cannot yet successfully run motors from it. It was for the purpose of preserving that simplicity of distribution which is peculiarly valuable in connection with large central stations, especially those already installed, and joining to this the same ability of running motors found on the polyphase system, that the monocyclic system, to which I am about to call your attention, has been perfected. You see it first in its two-wire form. Here, so far as the lighting distribution is concerned, it is absolutely identical with any of the alternating systems now installed, in simplicity, convenience and in the amount of copper necessary. The main circuit of the monocyclic machine constitutes a simple single-phase alternator, and so far as the lighting on the system is concerned is identical with it, connected in precisely the same way, feeding, if desirable, into the same circuits without change. There is, however, on the armature of the monocyclic machine a supplemental coil, shown on the diagram as connected to the middle point of the main winding on the monocyclic machine, from which a power wire may be led. This need be of small cross section, and only has to be carried to those points in the system at which it is desired to operate motors, and, as I shall presently show, this power wire enables one to run motors possessing the same desirable characteristics as the polyphase motors, and, indeed, generally identical with them, without in any way disturbing the lighting distribution, except in so far as Ohm's law is a necessary limitation on all combined power and lighting circuits. In the last diagram here we see the same device applied to an Edison three-wire system for the distribution of lights, along with which is carried the same insignificant power wire which permits the successful operation of motors. The value of the three-wire feature in the distribution of lights is evident, the amount of copper being the same as in the Edison system of the same voltage. With this monocyclic system we can compound the generators for any reasonable loss in the line, and can arrange the lighting system without incurring any troublesome questions of balance, so as to give as good regulation even as can be obtained on a direct-current system. Beyond this, we have the power of running motors.

It is instructive to glance over this list of alternating lighting systems to see their relative complexity and advantages. It is especially noteworthy that any and every method of distribution that saves copper introduces in some form or other the question of balance. This is the price we pay for reduction in cost of conductors. It has not seriously interfered with the use of the Edison three-wire system; in fact, those most familiar with that system were the first to make light of the difficulty; nor do I think it stands as a valid objection to the use of the polyphase systems in cases where they are desirable, as none of them are more sensitive in the matter of balance than the Edison three-wire system which is now in such extensive and uniformly successful use. We may further note that in each of the alternating systems where a very great saving of copper is accomplished, a fourth is necessary, at least if both lights and motors are to be operated; in each case, however, of trifling size.

Having now looked over the field in general, we may pass to the more minute consideration of the somewhat striking electrical peculiarities of the monocyclic system; peculiarities which, although they do not involve any particular complexity, are yet of decided interest.

The general principle of the system is well shown in this diagram. So far as the main work of the generator is concerned, its winding is closely similar to that of any well-designed alternator. The armature is of the iron-clad type and the winding is made in machine-wound coils which are invariably insulated, and can be very readily slipped into place. There is, however, upon the armature a second set of coils of cross section equivalent to that of the main coil, but composed of comparatively few turns, so that the room taken up on the armature is very small, and owing to the shallowness of the slots necessary to accommodate this second or teaser coil, the output of the machine, considered as a single-phase generator, is not affected. This teaser coil is located with reference to the main coil, as shown in the diagram. Its place on the armature is midway between the other coils and the electromotive force generated is in a direction at right angles to that of the principal coil. It is evident now that if we connect the terminal of this teaser coil with either of the terminals of the main coil we shall get an electromotive force compounded of the two, and in some intermediate direction. In general, by varying the proportions of the two coils, and hence their electromotive forces, we could obtain

a resultant electromotive force between their terminals having any angle we pleased with either the main or the teaser coil. If, then, wires are taken upon the line from the terminals of the main coil, and also from the teaser coil, we can obtain from the main line three electromotive forces, two of which are symmetrically situated with reference to the E.M.F. of the teaser coil, and bear to it any phase relation that we please. One of the most convenient arrangements, and that which is most generally adopted, involves such a relation of the electromotive force of the teaser coil to that of the main coils that we shall have on the line three electromotive forces approximately 60 degrees apart. In other words, the resultant E.M.Fs. between teasers and main coils are each 60 degrees from the E.M.F. of the teaser coil. Such an arrangement is that shown in the diagram. Under these circumstances, it is clear that if one of these electromotive forces were reversed, either in transformers or anywhere in the translating devices, the result would be three electromotive forces 120 degrees apart, one of them having been turned through an angle of 180 degrees. Meanwhile, the relation between the power wire, which is connected to the teaser coil, and the outside wire has no effect upon the electromotive force between these outside wires, since the electromotive force of the main coil itself does not interact with the power wire, except in so far as a portion of it may act with the power wire to form a resultant phase and electromotive force for running motors. Consequently, so far as lights are concerned, the two outside wires behave precisely like the leads from any other alternating generator, while so far as motors are concerned, we have the power of getting our three electromotive forces 120 degrees apart, and hence have the same magnetic effect as with a three-phase system. The arrangement of lights and motors with this device is clearly shown in the diagram. It is evident that we can take from the outside wires of the monocyclic system either arc or incandescent lights anywhere and to any extent the capacity of the machine permits, working for the incandescents either two or three-wire distribution at option. For a motor, two transformers are connected anywhere we please, one between the power wire and each of the outside wires. At this point the resultant phases come into play, and the necessary reversal of one of the electromotive forces is accomplished by the very simple and obvious device of reversing one of the secondaries, as shown in the diagram. To the secondary circuit thus constituted, we can connect a standard induction motor which will start and run as well as if connected to a regular three-phase system, or instead of reversing one of the transformer secondaries we may accomplish the same virtual reversal of the electromotive force by reversing one of the coils in the motor itself. We, therefore, have a system which, so far as lights are concerned, is a simple alternating system; so far as motors are concerned, the dynamical equivalent of a polyphase system. With a differently proportioned transformation we could place upon the secondaries two electromotive forces 90 degrees apart if necessary, and then run two-phase motors instead of three-phase motors if there were any object in so doing. Such an arrangement, however, would be less desirable than that of the quasi three-phase system, for the reason that without gaining anything in the motors we should have to generate a larger electromotive force in the teaser coil, and hence take up more room on the armature with it; perhaps enough to have an effect upon the output of the machine considered as a single-phase generator. It is sufficiently evident that the method shown would not be the only way of getting the same result. For example, in this second diagram a somewhat different arrangement is shown accomplishing precisely the same end. Here our object is to operate secondary mains on the Edison three-wire system, and in connection with them to run motors at any point we please. A large transformer to which the secondary is connected on the three-wire system is therefore installed and the secondary mains distributed in any manner we please. A second and small transformer, proportioned to the total amount of motor service desired, is connected as shown in the diagram, and the power wire leading from it is taken through the whole or part of the three-wire system. The device is analogous to the arrangement of the generating coils themselves, and the result is the ability to operate a standard induction motor by connecting it anywhere on the three-wire system to the two inside wires and to the power wire. Such an arrangement as this is immensely convenient in distributing power and light in cities where, for example, it is desired to establish an extensive system of secondary mains through Edison tubes or other convenient underground distribution. It is, furthermore, interesting to know that one is not confined to the use of either two or three-phase induction motors, since a monocyclic generator connected to the primary circuit makes an excellent synchronous speed without the assistance of a starting motor, in this particular being vastly superior to the pure single-phase synchronous machine. But, it may be asked, how about this power wire? In case, for example, of a transmission over a considerable distance before the distributing point is reached, must the power wire be part of the transmission system? In answer, I need only call your attention to the fact that the essential point of the monocyclic system, so far as motors are concerned, is the establishing of an electromotive force bearing the same relation to the system as is borne by the teaser coil of the generator. Consequently, in case of a transmission plant, the main generators at the distant station may be simple single-phase machines, the subsidiary electromotive force being furnished by a synchronous motor or similar device at any point in the system. So we might readily have an extensive transmission with a monocyclic machine in the sub-station of such size as is necessary to furnish current for what motors may be upon the system. The power wire would then run only to the sub-station. Another interesting peculiarity of the monocyclic system, and one which is not without importance in case of an extensive power distribution, is the following:

Under ordinary circumstances, induction and synchronous motors are wound so that the counter electromotive force affects the system in a perfectly symmetrical manner, and the current flows over all the wires with some degree of symmetry in response to the demands of the motors on the system. It is customary, however, in the monocyclic system to employ motors so wound as to throw a high counter electromotive force into the power wire when the motor is at speed and loaded, thereby reducing the normal current carried over the power wire to a purely nominal amount, and this can evidently be done without sacrificing much in the matter of starting, since at the start all the counter electromotive forces in the motors are zero. We have, then, a motor system of a type really peculiar to the monocyclic system, in that each motor will start under the same conditions of impressed electromotive force as if it were a polyphase motor; while, when at speed and loaded, it would be operating virtually as a single-phase machine. If, however, it were overloaded so that it would tend to slow down or stop, sufficient energy would flow over the power wire to bring it back to speed, just as if it were a polyphase machine. This is only one of various interesting ramifications in the systems when developed to meet special conditions.

The connections shown in the diagrams, however, are those of the most direct applicability, and probably which would be most extensively used for central station service. At this point it may be appropriate to ask what is the disadvantage of such a system. It evidently secures exceedingly marked advantages in the ability to operate the lights on existing circuits or with the simplest possible kind of distribution, and at the same time to run at any point in the system synchronous or induction motors of well-tried and familiar types. The question can be readily answered; in fact, the answer is almost obvious. The price which we have to pay for this advantage is the installation of the power wire, which necessarily adds something to the weight of copper in the system and to the trouble of installation. Under all ordinary circumstances the power wire need be of trivial cross section compared to that of the other wires, since, as a rule, the energy required for operating the motors from the given central station is small compared with the total capacity of the station, and further, it is worth remarking that the monocyclic motors, either synchronous or induction, will run perfectly well if the power wire is disconnected after the motor is at speed operating them as single-phase machines. It is, of course, well known that the single-phase synchronous motor gives admirable results, and it is also true that a single-phase induction motor can be constructed of excellent efficiency and other electrical properties. The only material difficulty in this case is to get the motor to start with a good torque. The monocyclic connection enables this to be accomplished. After the motor is at speed the power wire becomes no longer necessary to successful operation, so that in spite of the necessary existence of the power wire it is easy to see that the additional amount of copper is not likely to be burdensome in central station operation. It would hardly ever be necessary to install a power wire of more than one-fourth the joint cross section of the others, as given in the diagram, and generally a much smaller wire will suffice.

I have thus endeavored in a brief space to give a good working idea of the monocyclic method of combined light and power distribution, which has been devised and is urged upon the public as

specially adapted for the work of central station distribution on account of its unique simplicity in practice. As to what has already been done in the installation of such apparatus, a considerable number of these monocyclic generators are in daily use in central stations, for the most part operating over circuits already established and displacing the higher frequency alternators which had been previously used. They are giving excellent results, and the operation of the motors, wherever employed, has been highly satisfactory. The system, therefore, needs no extensive exploitation on paper. After once pointing out here the principal and general advantages of the system, it is better to let the plants already running speak for themselves, and let their verdict be final.

DISCUSSION.

Mr. Kelly: I suppose I can honestly begin by paying a tribute to the ingenuity of the devisers of the system; but it is scarcely necessary, because we all know what they can do—they have already proved themselves. I cannot help feeling, however, that in this case their ingenuity has been somewhat misapplied. The most serious fault with the system is that it did not come soon enough. If it had come before the polyphase systems had been worked out, perhaps we would not have needed any polyphase system, but, coming when it does, it seems to me a step backward. In the first place, the generator, as Dr. Bell explained, is substantially a single-phase generator. Now, in any given generator of given magnitude it is not possible to get the same output and regulation as it is from the polyphase—when worked single-phase as when worked two-phase. Dr. Bell seemed to think that the two-phase was in trouble, because of the difficulty of balancing the two circuits. I am more familiar with that system than any other, and my own reason for preferring it is because the regulation is better than if the work was thrown on one circuit. We have found that there is no more difficulty in balancing than in the Edison three-wire system. When it comes to the lines I suppose it is in this point that the chief advantage of the monocyclic system is supposed to lie; but the system requires at least three wires and any polyphase system does not require more. Where lights only and not power are required, it only needs two; in practice that is all that any polyphase does in any district where lights only are required. You need only run a pair of wires, so that in this respect there does not seem to be any gain in the monocyclic system, but the cost for copper is, at the least, according to Dr. Bell's diagram, higher than it is with the plain single phase, while the cost of copper in the two-phase three-wire system is very materially reduced. In the circular distributed I see it is stated that where power only is to be transmitted by means of the monocyclic system, the third wire is of the same section as the other two, making an addition of 50 per cent., but if the system is so working that this third wire is really a power wire and conveying energy, then there is not only this additional cost, but the percentage of drop in the circuits is increased beyond that in the single-phase system. As to the question raised by Dr. Bell in regard to the periodicity at which motors can be worked, there are undoubtedly great advantages in cases of long distances, or transmission with low periodicity, but one of them is not the possibility of operating motors. There is no difficulty in making polyphase motors of 16,000 alternations which will have high efficiency and start with large torque. As to the efficiency of the motor in the monocyclic system, there is nothing to be said against it, because the motor is substantially a polyphase motor, and whatever the polpyhase motor will do the monocyclic will do.

Mr. Steinmetz: I am very much honored by being able to speak before such an association as this, and may say that I have heard with very great interest Dr. Bell's interesting paper, and with much greater interest Mr. Kelly's remarks. I can, however, not quite agree with his statement that the single-phase alternating current system is antiquated and superseded by the polpyhase system, and that therefore the monocyclic system is behind the times. The polyphase system has been before us now for nearly ten years. It made its appearance shortly after the single-phase system, and at a certain time after the Frankfort exhibition, when our electricians came back from Europe and talked excitedly of what they had seen, everybody seemed to think that the single-phase system would soon disappear altogether. Nevertheless, we have now thousands of single-phase stations running, while the polyphase system is only just beginning to be used in special cases. Therefore I feel confident that the polpyhase system will never be able to supersede the well-known single-phase system of old, but find that it possesses a limited application, although being very valuable at the proper place. The monocyclic system is entirely single phase; that is to say, the total flow of energy issuing from the generator passes through zero and is fluctuating; while the polyphase systems share with the continuous system the common feature that the flow of energy is never at zero, but more or less constant. E. M. Fs. of different phases or currents of different phases do not constitute the polyphase system; for in the ordinary single-phase system if an induction coil is connected in series to incandescent lamps you get E. M. Fs. displaced from each other by 90 degrees, that is quarterphase E. M. F.; and in a loaded transformer and in a transformer running light the currents are displaced in phase. In neither case, however, we speak of a polyphase system. The polyphase system is indicated when both E. M. Fs. as well as currents differ in phase from each other.

Now, with regard to the statement of Mr. Kelly that the output of a polyphase machine is larger than that of a single-phase machine, that is a common mistake repeated now for years. It means that in the polyphase armature more wire can be put than on the single phase armature. However, the output of an alternator is not limited by the amount of wire you can put on the armature, but by the armature reaction; or rather, by that amount of armature reaction which can be taken care of by the field; and in a single-phase machine you can, by compounding, take care of a very great armature reaction which you cannot take care of in the polyphase machine, where small armature reaction causes unbalancing of the circuit. In consequence of which the output of a polyphase is less than that of a single phase of the same size and speed; or at least not greater.

Prof. Thomson: The paper of Dr. Bell has been so full and so clear that it leaves very little for me to say, except that I can express my agreement with the statements of the paper, and that furthermore, after due consideration, I think Mr. Steinmetz has the right of it. He has given an enormous amount of time and attention and close study to the question of polyphase, single-phase and other systems, and has originated a number of remarkable combinations, one of which is the monocyclic system. I think the system undoubtedly accomplishes all that has been stated by Dr. Bell to be its advantages.

Mr. Scott: I have been, and I am sure all of you have been, very much interested in the presentation which has been made by Dr. Bell of the monocyclic system. We can take it, I think, as a carrying out of the remark that was made in an association a year and a half ago, that when we have an alternating polyphase system, we have something that we can do something with. It is flexible, we can twist it about, we can make a two-phase and three-phase system—and now a monocyclic system—variations of the polyphase system, and go from one to another and get the different advantages which any one of these may present for different kinds of work.

We have had the characteristics and advantages and merits of this system pointed out. It may be well, it seems to me, to bring forward some of the questions which arise with respect to the points which have been brought out so that they may be answered now, and that we may determine the relation of this system to the other systems. To these who are not immediately and technically familiar with the subject, there is apt to be a sort of haziness about it. We hear first about the two-phase and then about the three-phase systems, as if they were entirely new and different. As a matter of fact there is no fundamental difference between the two. Then we have a monocyclic system. What relation does it bear to the other systems? Is it radically and entirely new? Does this euphonious name mean something which is a departure from what has gone before, or is it a modification, and if so, of what is it a modification?

Starting with the source, the generator itself is just now somewhat in doubt. The single-phase generator is best, because it regulates better and has a better output. The polyphase generator, it is also stated, regulates well and has a good output, and without carrying that further we can all be satisfied by taking our choice. We will consider a few points made with respect to the transmission circuit. There are one or two statements of Dr. Bell which can either be called in question or certainly a little modification made to them. A two-phase four-wire system, which he has given as the third figure, he has considered as the correspondent of the alternating two-wire circuit only, and has not considered it applicable to use in a three-wire connection, in which the amount of copper is so much less. The reason of this was the added complication of running two three-wire circuits. That might be true if the area to be covered were quite small, but as central stations are usually run the lines are carried out in different directions. In alternating stations there are

anywhere from three or four to a dozen of several dozen feeding circuits running in different directions and supplying different territories. It is just as easy to divide these up into three-wire circuits for lighting, as the different parts of the city to be supplied, or the districts, are separated, as it would be if all of the circuits were of the same phase. If, therefore, the distribution can be carried on by the three-wire plan, the cost of copper here would be materially reduced and be made equal to that of the three-wire single-phase system. Considering the two-phase three-wire system, the figure 145.5 was stated as the relative amount of copper used, and that a possible reduction of 72.8 if the extreme E.M.F. can be increased above that for the first figure upon the diagram, which is for the two-wire single-phase system. The assumption upon which all these figures have evidently been made is that there has to be a definite E.M.F. for the carrying of lamps. If that is to be carried through the various diagrams, then the 72.8 is a proper figure. If, on the other hand, a limited voltage is the consideration to be met, we have in the ordinary three-wire circuit twice the E.M.F. of the single-phase circuit. If the same be applied to the two-phase three-wire circuits then the amount of copper would not be 72.8 but one-half, or about 36, so that the figure 145.5 in connection with that diagram is not in accordance with the assumption of the E.M.F. being controlled by the lamps in circuit, and if the highest E.M.F. allowed is that of the three-wire circuit, then the additional figure for the weight of copper for the two-phase three-wire system should be 36 in comparison with the other figures.

Another point in connection with the lines is the unbalancing of circuits. It was stated that the two-phase three-wire circuit is one which is liable to unbalancing because of the reaction of one circuit upon another. While this is true in certain cases, in ordinary working these would be met with but seldom. The next point in the system, after going through our transmission circuits, is the transformer. The transformers for transforming a given amount of energy for lighting or for power, by the two-phase system, in which one transformer is placed on each of the two phases, is the same as that for the single-phase system. For the three-phase system, in which transformers are connected across each pair of mains, the converter capacity is the same; that is to say, if we have six transformers, we may connect them in parallel across the single-phase circuit, or we may connect them in two sets of three each on a two-phase system, or we may divide them into three groups of two each on the three-phase circuits, and each transformer will have the same individual capacity in each position. When, however, these transformers are connected as in the diagram illustrating the monocyclic two-wire system, then, as has already been pointed out, they do not operate in their ordinary way. Although the E. M. F. upon them may be normal, the currents flowing through the transformers differ from those in ordinary cases. They are not in phase with the E. M. F. upon the transformers, and the output of the transformers is reduced by a very appreciable amount—if I am correct in my present recollections, some 16 per cent. Thus, transformers of about one-sixth greater capacity would be required for operating a motor under this system above that which would be required if the same motor were operated by two-phase or three-phase systems.

The transformers in the monocyclic three-wire system also seem to require an excess capacity. If the large transformer in that diagram is the one which supplies the lights and operates the motor when the motor is doing something, then the little auxiliary or teaser transformer is one which is useful only at the start, and contributes nothing to the regular working of the motor, according to the assumptions which have been made. This transformer, therefore, is an additional piece of apparatus which must be provided in the system.

With regard to the motor itself, I observe that the motor in the monocyclic two-wire system is a three-phase motor and nothing else. I understand that the motors used are the standard three-wire motors, and the motor itself does not know the difference, where it is getting its supply, whether from a regular three-phase system or a two-wire monocyclic system. The transformers for this motor on the three-wire three-phase system would naturally be the three. We seem here to have cut off a part of this system by cutting out one of the transformers. We are not keeping the symmetrical arrangement now, but are supplying the motor by but two transformers, leading to the result to which I have just called attention, that is, a larger transformer capacity. The reversing of the secondary coil of one of the transformers, if I understand the connections and arrangement, would be obviated, and the transformer would be connected directly without this crossing if the primaries of these transformers were directly connected to three-phase mains. Suppose we have a system, then, with three-phase mains with three transformers connected, feeding respectively the three circuits of the motor. Now we cut out one of these transformers, but our motor will still run, but without the same efficient performance of the transformers. If we change the relation of the middle wire at the dynamo, or change the voltage of this wire, we can do so in such a proportion that the phases of the two primary circuits will not have their former relation—will not be 120 degrees apart, but 90 degrees apart. In this case, it becomes necessary to reverse one of the secondaries in order to obtain two currents 120 degrees apart for operating the motor. If, therefore, the teaser coil were wound with a different number of turns to give a higher E.M.F. we might have a three-phase generator supplying directly three-phase mains. What this seems to be, then, is really the elements of the three-phase system distorted somewhat by changing the E.M.F. on the middle or teaser wire and reversing the secondary of one of the transformers and leaving out the third transformer. So much for the motor which operates from the two-wire monocyclic system.

The motor on the three-wire system seems to have somewhat different relations. This is not a three-phase motor, but, I take it, is a two-phase motor, and it is rather interesting.

Dr. Bell: It is a three phase—the same motor as the other.

Mr. Scott: Very good, but on the diagrams I have seen of this monocyclic motor, I have taken it as a two-phase motor, the two windings being given in the diagram as two coils placed at right angles to one another. The very reason for bringing up this discussion and making it so full at this time, is to get a correct understanding of these motors. The understanding which I got from the diagrams and explanations which I have seen of the system, seem to me to represent a two-phase motor, one of the circuits being wound through directly similar to the monocyclic generator. This motor has been pointed out—I do not remember whether in the paper Dr. Bell has just read, or not—as similar to the monocyclic generator, which is stated to be a single-phase machine, wound with one winding straight through from one end to the other, with this little auxiliary or teaser coil connected between the middle of that coil and a third terminal. If this be the case, then it seems to me that this motor is either a single-phase motor or a two-phase motor. The explanation given of the operation of this motor has not been very complete to-day. If I make a mistake in drawing on other sources of information in regard to it, I hope I will be corrected.

This motor I have taken to be a single-phase motor when running at speed, but essentially a two-phase motor, which is supplied by the three wires which are operated by two transformers which have E.M.Fs. at right angles, or the 90-degree relation of the two-phase motor. We are supplying, then, to this motor the output of two converters which are operated at a difference of 90 degrees. All the circuits of the motor are active while the motor is coming up to speed. One of the windings on the motor is somewhat different from that of the windings on the transformer; it is not exactly proportioned in both of its circuits to the E.M.F. supplied, so that when run at speed one of the circuits does all the work. It is very much as if two transformers are connected in parallel, one giving 100 volts and the other 99 volts. If we put a load on the two transformers connected in multiple until the E.M.F. drops to 99 volts, then one of the transformers would be carrying all the load and the other nothing. The motor described here is the same motor, if I understand it correctly, as is described in the patents granted to Mr. Steinmetz. Then it seems to me that this motor is very similar to a sort of lop-sided two-phase motor, stronger on one side than the other. The two circuits operate with fair effect to bring the machine up to speed and then one of the circuits takes all the load and the other has but little to do. The motor in running at full speed and doing its regular work operates as a single-phase motor. A single-phase induction motor will not carry the same load that the two-phase induction motor will. Any one who has operated two-phase induction motors knows that one circuit may be cut out and the machine will continue to run, but it will not carry the same load as before. If that be true and the information upon which I understand the connection of this motor be true, then this monocyclic motor seems to be a rather decrepit two-phase motor.

There is one point to which attention was called by my able friend Mr. Steinmetz to which I take exception. That is his definition of a polyphase system or a polyphase motor. He was pleased to say that difference of phase in E.M.F. with no difference in current does not constitute a polyphase system, and he pointed

out that if a coil and a lamp be placed in series the E.M.F. measured directly across the lamp and the E. M. F. measured directly across the coil would not be in phase with one another, but would occur at different times. So also if a coil and a lamp be placed in multiple so that the same E.M.F. is on the terminals of both, then the currents are not of the same phase. But he held that neither of these would constitute a polyphase system, because the flow of energy was not constant. A constant flow of energy may be taken as a definition of a polyphase system, so might difference of E.M.F. or difference of currents. As I understand a polyphase system, I do not mean that the E.M.F. at one part of the circuit may be one thing and at another part somewhere else another thing, either at a great distance or connected with a different piece of apparatus; that would not necessarily constitute a multiphase system; but if the two different elements with difference of phase cause the operation of that apparatus, then we have the essence of a polyphase system. If we have a motor and wind its circuits in such a way that the circuits shall differ in capacity or self-induction, if the currents in the different circuits differ in phase, and owing to this the apparatus operates and the motor runs, then we have something which should be legitimately considered as polyphase apparatus. We have an apparatus which operates due to the difference of phases, or to too many phases, and in the polyphase motors that is the characteristic element. The element which causes rotation, the fundamental element, seems to be the shifting of the magnetic field in the apparatus. It is not fundamentally essential to the operation of such an apparatus that the currents give equal energy to the apparatus at all times, but that they may be supplied in such a way as to give the shifting field, which will cause the rotation and running of the apparatus. I would, therefore, call a multiphase machine one which has in it a shifting magnetic field of many phases, or currents producing these magnetic fields, rather than one having constant flow of energy to the apparatus.

The power wire operating in the monocyclic three-wire system is said to be a powerless wire. This wire is for the purpose of operating the motor while it is coming up to speed. The two great problems in an alternating current motor are: first, the bringing of the motor up to speed; and secondly, keeping it there. These are two different problems, and different methods are devised for effecting the two different results; and very often the elements which contribute to one detract from the effectiveness of the other. The power wire, if I am right in understanding this motor, does not necessarily supply power to the motor at the time when the motor is running at full speed, but it contributes to the power which is required for bringing the motor up to speed, and would continue to deliver power to the motor instead of lying idle and resulting in so much idle copper in our system if the motor were a complete and symmertical motor instead of one which has possibly been made defective to meet the requirements of this system.

Dr. Bell: The first question raised may be granted, that the monocyclic system is a modification of something. Is it now to be considered as a single-phase or two-phase system, or a polyphase system of some sort? I think that question was clearly answered by Mr. Steinmetz when he pointed out that you must consider as a polyphase system one in which the energy remains constant—the common characteristic of all polyphase systems, whether evenly balanced or unbalanced. In the monocyclic system we have three currents substantially in phase with each other and the total energy passes through zero. I fail to see how the widest possible extension of the definition of a polyphase machine could be made fairly to include it. The most that could be said would be that there might be a limiting case in which the unbalancing of a polyphase system might go on until the total energy would actually pass through zero. If that is so, it might serve equally well as a limiting case for either the single phase or the polyphase system. It is certain that the monocyclic in its operation suggests a polyphase system. In the character of the currents which flow through it, and in the distribution of the energy, it is peculiarly single-phase in its character. I was interested in Mr. Scott's remarks on the subject of the four-wire connection of the two-phase; and in the second place, the three-wire connection of the two-phase system. Now, with a four-wire connection, it is, of course, possible to use the Edison three-wire system on each branch, if one so desires; but in order to do so, and to run motors at the same time, one must unlink the two three-wire systems; in other words, you must have two three-wire systems, each system being approximately balanced as to itself, and each three-wire system balanced as respects the other three-wire system occupying the same territory. They must be interlinked for motor service, and that is the reason which, I maintain, bars out the two-phase four-wire system from employing the Edison three-wire connection, just as it must bar out in the same way, and even more effectively, the three-phase system from operating on each of its three phases an Edison three-wire system. It makes a complication of circuits for general distribution which would be perfectly intolerable, two three-wire circuits in the same territory, and each balanced with respect to the other—it would be something better imagined than described. In certain cases, for lights only, it may be applied, because you are at liberty to scatter your circuits, but even then it would require more or less balancing of the two systems, else you get into trouble with one side of the machine having a greater load than the other, which causes a difference in drop which cannot be compensated by compounding.

With the two-phase, three-wire system, Mr. Scott's point was well taken on the question of maximum voltage. However, if you are dealing with the maximum permissible on the transmission line, where the thing to be considered is not the maximum on the distributing system to translating devices, but the maximum permissible on the whole system, and if you confine yourself to that, you find that combining the two-phase into three wires requires excessive copper. If you confine yourself to the secondary system alone it will be possible to permit the same maximum voltage as on the straight Edison three-wire, and I should say that the same rule would apply to the reduction of copper in the three-phase three-wire system, or any other systems, in varying degree according to their character.

As regards the question of unbalancing I think I stated with a fair degree of distinctness that with any polyphase system, though unbalancing may occur, and occur in a serious degree, I do not believe it would be a common occurrence. I think I specifically included the polyphase systems in general.

With regard to the question of the reduced capacity of transformers operating on three-phase or monocyclic systems: as a matter of fact there are three plans of working, we will say, with a three-phase system as regards its transformers; in the first place, we may have a composite transformer including all three legs of the circuits, which has been used with very fair results. Next we may use three transformers, or, finally, only two transformers. Sometimes it is more convenient to use three, and sometimes two. We must remember that there are not to be had an infinite number of sizes of transformers, nor an infinite number of sizes of motors. Therefore it is sometimes difficult to find transformers which will exactly fit a given horse power of motor, and the loss of capacity which is thus met in furnishing transformers too large for the motors (because we must be sure to have them large enough) may easily amount to 10 or 15 per cent., either with two or three phases, and unless special transformers are made to fit the motors, we are liable thus to require an increased total capacity of transformers, as well on two-phase as on three-phase systems. With the three-transformer connection for the three-phase circuit we have one very material advantage, which, perhaps, makes it worth while to employ it in many cases, and that is if one of the transformers for any reason is crippled, we can operate at least two-thirds of the output with the remaining two; whereas, on the two-phase system, if one transformer gives out the motor is crippled, either by overloading and stopping absolutely, or able to run at half output as a single-phase motor, but in no case starting until the transformer is fixed. If two transformers are used, the statement has been made that the loss in output in connecting three-phase transformers is about 16 per cent. I would like to see experimental evidence brought up in this case. We have been informed in many well written technical articles that the output of the polyphase machine was thus and so in comparison with a single-phase machine, and we know that the facts do not fully bear out the theory. We are now given similar information in regard to the transformers. While I am not prepared to dispute the fact without having experimented on it, I would like to see some evidence that the difference in output rises to any practical magnitude.

As regards the teaser transformer, I think we may consider the secondary transformer on the monocyclic three-wire system as practically part of the power wire. It needs to be of small size and furnishes only a small amount of energy. With that connection that one transformer furnishes the power wire for the whole three-wire system. It is not a part of each motor, simply a part of a power wire, and as such it may be taken as a part of the installation

belonging to the three-wire system. The single small transformer in the system furnishes the entire power wire for the whole system.

As regards the motor on the monocyclic two-wire system, it is correct, in a sense, to say that the motor does not know whether it is on a three-phase circuit or a monocyclic. As regards its operation, it does not know—that is, as regards the direction of the E.M.Fs. in it.

It is a matter of perfect indifference which system it is on; but as regards the character of the currents and their direction, if the motor possessed an ammeter to put in its own coils, it would find there was a very large difference in the distribution of currents. As regards its magnetic qualities it would not matter, although the actual distribution of the current is widely changed. We have in the monocyclic induction motor a motor which, in its operative qualities, is like a polyphase motor. Nevertheless, the distribution of currents in it, although resulting in a perfectly symmetrical production of motive power, is something that you cannot find in any polyphase motor. It depends on the particular action used in the monocyclic system. It has essentially a single-phase current, although its effect as regards magnetism is closely similar to that of the true polyphase motor.

As regards the motor on the monocyclic three-wire system, I was much pleased with the ingenuity with which Mr. Scott constructed a large, able-bodied and well-dressed man of straw for the purpose of knocking the gentleman down and jumping on him with both feet. The motor is not a two-phase motor of any kind. It is an ordinary induction motor such as is used indifferently on three-phase or monocyclic systems. Doubtless, from the experience of the speaker, he realized how bad a bad two-phase motor could be. The winding of the monocyclic motor is in every respect similar to that of the three-phase motor. There is a possibility, and sometimes a great convenience, in being able to work a monocyclic generator as a synchronous motor. Used in such a way it works during its operation like any other synchronous motor. It is a possibility which is sometimes very convenient; the motor starts itself, and the teaser coil, when the motor is up to speed, produces no effect on the rest of the system if the motor is properly designed with reference to suppressing the E.M.F. of the teaser circuit. In the monocyclic three-wire system we have in the first place a three-phase motor structure, but operating on a monocyclic three-wire and teaser circuit, with the properties and distribution of currents, or electrical character, of the single-phase system. The actual details of operation in a monocyclic motor are somewhat complicated. Substantially we have a structure which in all its characteristics is only proper to be operated on the monocyclic or three-phase circuits. The currents which flow through it, however, are not three-phase currents, the E.M.Fs. being, however, 120 degrees apart. The currents are substantially in phase, but the magnetism produced is so distributed as to give a perfectly symmetrical torque on the motor, just as though it were run upon a polyphase circuit; a point which I think justifies me in the remark I made at the beginning, that the monocyclic system is to be regarded, not altogether as a modified and glorified single-phase, nor again as a decrepit and disreputable polyphase system, but rather as in a class by itself.

Telephone Rates.

One of the members of the New York Board of Trade states that the counsel for the Metropolitan Telephone Company admitted at a former investigation that the average profits on each New York exchange subscriber for the six years ending with 1886 (deducting toll line service) was $72.73. In 1881, the profits per exchange subscriber were $39.84; 1882, $71.19; 1883, $91.05; 1884, $72.82; 1885, $81.15; and 1886, $80.33. It is claimed that the sworn testimony of the company's officers at that investigation also showed that the company's net profit in those six years on the cash capital invested amounted to 473.91 per cent., that the net profits in 1885 exceeded 116 per cent., that they exceeded 147 per cent. in 1886, and over 145 per cent. in 1887. While the telephone rate was $60 a year, and afterwards raised to $150, and again to $180 a year, the company realized $2,843,454.53 profits (net earnings) in six years on an original cash investment of $600,000. At present 9,500 regular subscribers pay an average rate of $175 per year. Half the total number of subscribers, however, pay $240 a year, 3,000 pay a rate based on the service rendered and 2,000 pay rates below $240 a year and down to $150. It is claimed by the telephone company that at present better instruments are used and a metallic circuit, the latter greatly increasing the fixed charges on the service.

A New Method of Measuring Illumination.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

In almost all cases the object of artificial lighting is to provide a sufficient intensity of illumination upon the illumined surfaces. In practice, the illumination is generally required in order to permit some kind of work to be carried on. In any case, the character and intensity of the illumination will necessarily vary with the nature of the work.

In a room in which reading only is to be done, it suffices if the proper illumination is obtained on the pages of the books, *i. e.*, on the reading tables, though the remainder of the room is comparatively dark. Where machinery is to be operated, the main light is generally required upon certain moving parts. In cases, however, where the character of the work requires the attendant to move about, or to observe some distant part of the machinery, a necessity exists for avoiding marked contrast in the illumination of the room. Here it is clear that the use of a single source, such as an arc lamp, is undesirable, since, apart from the fact that such use would produce a powerful illumination in the immediate neighborhood of the lamp, it would necessarily cause annoying shadows which could only be avoided by diffusing and scattering the light. It is evident, therefore, that in practice it is the illumination rather than the luminous intensity of the sources which is desired to be measured.

Although experience will enable the electrical engineer to determine the probable number and grouping of the separate sources of light, such as incandescent lamps, that will be required to produce any desired illumination in any given space, yet it is well-known that no rigid rule can be laid down as a safe guide in such cases, since the character and color of the surfaces of the walls and ceiling will largely influence the illumination produced by a given arrangement of light sources. The question, therefore, as to whether or not a certain area is properly lighted cannot be decided so accurately from a knowledge of the number and grouping of the luminous sources and their candle power as it can from a method of actually measuring the quantity of light received per unit of area by a particular surface or surfaces whose illumination it is desired to know. In other words, the question at issue is not so much the photometric intensity of the sources of light and their distribution, as it is the degree of illumination actually produced, and this question cannot be decided by the photometer, but requires the use of an illumination measurer or illuminometer.

Suppose, for example, it is desired to illumine a billiard room. Though experience must determine the number and position of the lamps, yet the commercial question as to whether or not the necessary illumination has been obtained upon the tables can best be determined, not so well from the number and grouping of separate lamps of a given candle power as by an actual measurement of the light received per unit of area on the table surfaces. In the same way, whether or not a certain grouping of lights over the tables is sufficient to illumine the rest of the room satisfactorily can be best determined by the measurement of the illumination produced in different parts of the room. Similarly, in a dining or reading room it is the illumination of the tables that has to be specially provided for, and the question of proper lighting is best determined from a determination of the illumination of the tables irrespective of the character or number of the lights present, except, of course, in so far as æsthetic requirements are concerned.

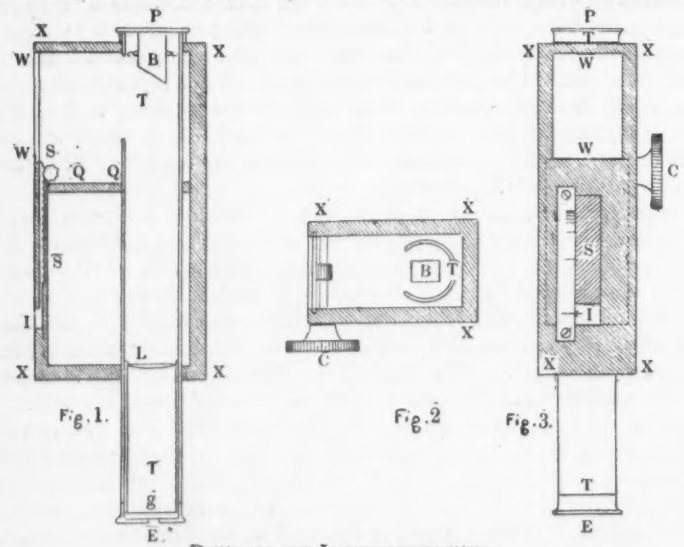
In street lighting, the requirements are that sufficient illumination be obtained on the surfaces of the streets, houses, vehicles and persons to be able to discern them clearly at reasonably sufficient distances. This primarily requires a certain intensity of illumination over a given area; and can best be determined by an actual measurement of the minimum illumination, rather than by calculations dependent upon a number of complex conditions, of which the photometrical intensity of the separate sources employed is but one.

Measuring the illumination rather than measuring the intensity of the separate luminous sources would remove a source of great annoyance both to electrical engineers and to municipalities, by rendering unnecessary discussions as to the candle power of the incandescent or arc lights employed; since, if the contract between the city and the lighting company be so drawn that it be agreed that the illumination in any part of a lighted street, for example, in the absence of moonlight, shall not be less than a certain minimum, all questions as to the candle power of the separate sources will fail to affect the contract, and it only remains for the electrical engineer to provide such lamps as will, at the spacing employed, give the illumination contracted for.

So far as we know there is no actual apparatus in existence, other than that we are about to describe, which will directly measure the intensity of the illumination at a given point, except the portable photometer of Prof. Weber, described by Mr. Heinrich on p. 422, Vol. XI., No. 7, July, 1894, of the "Proceedings of the American Institute of Electrical Engineers." In Weber's photometer the illumination received upon a screen from a small standard amyl acetate or benzine lamp is compared with the illumination to be measured. The difficulties of obtaining a reliable portable standard lamp, the rather cumbersome size of the apparatus, and the fact that it does not obviate the difficulty of comparing illuminations of different colors, have led us to devise a new instrument based on entirely different principles. We call our instrument an illuminometer, and have filed applications for a patent on the same.

A certain intensity of illumination is required to render a definite object, viewed at a definite distance, clearly delineated to the eye. It is well known that the illumination received upon the printed page of a book or newspaper must have a definite value in order to render the printed characters legible, and that the intensity of the illumination so required will, for a normal eye, depend upon the size and character of the print.

We employ this principle in the operation of our illuminometer as follows: a small test object of, say, printed characters, is placed in a darkened box, sufficiently small to be readily carried in the pocket. The test object is exposed to illumination received from a translucent plate of porcelain or opal glass, which receives, directly on its surface, illumination whose intensity is to be measured. Since the test object receives the light from this plate by transmission and subsequent diffusion, it is the area for the translucent plate exposed to the test object, in order to just render the latter legible to the eye, that determines the intensity of illumination upon the plate. A focusing eye-piece is placed opposite to the test object for purposes of annulling the effect of any focal abnormalities of vision. A sliding shutter, movable by a milled-headed screw, permits the



DETAILS OF ILLUMINOMETER.

effective area of the opal glass plate to be reduced until the amount of light received by the test object just permits of its legibility.

The detailed construction of our apparatus will be understood from an examination of Figs. 1, 2, and 3, which represent respectively a longitudinal cross section, a transverse cross section, and a plan view. A box, *XX*, blackened inside to prevent the reflection of light, is provided with a tube, *TT*, as shown. The test object is placed on a block at *B*, opposite the focusing eye-piece *E*. At the top of the box is a window, *WW*, closed by a translucent diaphragm of porcelain, opal glass, or similar material. This diaphragm is placed so as to act as a secondary illuminator of the test object at *B*.

In order to regulate the amount of light which passes from the window, *WW*, to the test object, a sliding shutter, *SS*, operated from beneath by a milled-headed screw, *C*, is placed in guides beneath the window so as to cover any desired fraction of its surface. In order to determine the effective area of the window, *i. e.*, the uncovered portion which admits light to the test object, *B*, the index, *I*, attached to the shutter, moves over a calibrated scale, *S*, from which the amount of illumination on the window, *WW*, may be immediately read off in suitable units.

Calibration of the instrument is effected by exposing the window, *WW*, to known intensities of illumination in a photometer, or darkened room, and marking off upon the scale, *S*, the points at which the indications of the instrument are obtained.

By the illumination on a surface is meant the quantity of light it receives per unit of area. Illumination may be expressed in terms of some unit illumination, obtained from a definite source at a definite distance. Thus, a standard candle produces a definite illumination at a distance of a foot, and this illumination is sometimes called a candle foot. A less objectionable, and more generally recognized unit, is the illumination produced by an International standard candle at a distance of one metre, and this unit is called the bougie-metre or the lux.

The International standard candle referred to is the *bougie decimal*, or the one-twentieth of the violle, or molten platinum standard of light, adopted by the Paris International Electrical Congress of 1889. Authorities, unfortunately, differ as to the relative value of this decimal standard candle in terms of the British candle or sugg, which burns 0.1296 gramme per minute, but Everett, in his C. G. S. system of units, 1891, gives data which make the international candle 0.988, or about 1.2 per cent. less than the standard British candle. Approximately, therefore, one lux is the illumination produced by a standard British candle at a distance of a metre.

In employing our instrument for such a purpose as measuring the illumination upon the surface of a table illumined by daylight, candle light, or incandescent light, we place the illuminometer upon the table with its window up, so that its window, being, say, only two inches above the table, practically coincides with the surface whose illumination is to be measured. The eye is then applied to the eye-piece and the test object focused under full illumination. The shutter is then gradually moved over the window until the test object just remains legible, when the number of luxes in the illumination of the table are shown by the index on the scale.

The degree of accuracy with which these measurements can be made, though small as compared with such determinations as length, mass and time, nevertheless does not compare unfavorably with photometric measurements in general. It is well known that two observers may vary in their determinations of the candle power of an incandescent lamp by 5 per cent., and, when the lights to be compared have different colors, the variation is often much greater.

The mean error of a single observation with our instrument is about 10 per cent., that is to say, if a number of measurements be successively made of an illumination within the range of the instrument, the average deviation of any single measurement from the mean of all the measurements is, with the instrument here exhibited, about 10 per cent., although we believe certain changes we have in view will notably reduce this percentage. Some tabulated observations are appended. In the instrument exhibited, the graduation of the scale extends from four luxes, by single luxes, to 15, then to 35 in divisions of five luxes, then to 70 in divisions of ten luxes, while the highest reading is 400. The total length of the scale is 1.5 inches. The total length of the instrument is 6½ inches, its breadth is 1.5 inches, and its height, excluding the milled-headed screw, is 2¼ inches, so that the apparatus can readily be carried in the pocket. Its weight is ten ounces.

It might be supposed that two different observers having different limits of distinct vision would obtain different results in determining a given illumination by the use of our instrument. In point of fact, however, we find that by the use of the focusing eye-piece, distinct vision of the test object being readily secured for each observer, the results of different observers do not appear to differ by more than the limits of probable error for the apparatus.

It is known that an illumination of five luxes is sufficient to permit the reading of ordinary print, although, on physiological grounds, the eyes should not be used for continuous reading at illuminations less than ten luxes. Fifteen to 25 luxes may be regarded as proper artificial illumination for reading. In the same way, the amount of light required to permit the performance of other kinds of work is readily determinable. It is evident, therefore, that our illuminometer is applicable to the determination of the question as to whether the illumination of a given area is or is not sufficient for the character of work to be done, and that the measurement of illuminations can be made with a reasonable percentage of error for all intensities within the range of the apparatus. This range can be varied by altering the character and dimensions of the window, as well as the character and dimensions of the test object.

It will be evident that the advantage of such an instrument consists in the fact that it entirely dispenses with the necessity for the use of a portable standard of light, thus removing a constant source of unknown error in apparatus previously employed for this purpose.

Moreover, the instrument does not require any great skill in its use, and with simple directions for use can readily be employed by an inexperienced observer.

It is evident that our illuminometer will permit a direct determination of the candle power of a source of light by measuring the illumination produced at a fixed distance by that source of light alone. Thus, for example, if an incandescent lamp has its illumination measured at a distance of one metre from the centre of the filament, the number of luxes indicated by the instrument, when its window is perpendicular to the rays from the lamp, and all other sources of light are well cut off, will give directly the number of international or decimal candles in the lamp. It is, therefore, possible to measure the candle power of a lamp in its socket, provided all other lamps in the neighborhood be extinguished, and that a black, non-reflecting cloth be placed so as to prevent any appreciable amount of light from entering the window, except that radiated directly from the lamp.

Our illuminometer, therefore, becomes, indirectly, a portable photometer.

In the use of the instrument, care must be taken to keep the glass of the eye-piece, and of the window, clean, as, otherwise, the observation may be vitiated. The use of the focusing eye-piece is intended to avoid the necessity that might arise for wearing glasses, by which the quantity of light entering the pupil of the eye from the test object would be necessarily reduced.

Since the indications of our instrument depend upon the physiological effect alone, and not on the contrast of an unknown with known illumination, all questions as to difference of color in the illumination to be measured are avoided, so that a measurement of the intensity, *e. g.*, the candle power of an arc lamp, can be made without employing a special arc standard.

Apart altogether from the use of our apparatus, the National Electric Light Association doubtless recognizes the fact that there exists to-day no generally accepted standard of illumination. We would respectfully recommend that the association consider the advisability of officially adopting as the unit of illumination the lux, or bougie-metre, *i. e.*, the illumination produced by a decimal candle at the distance of a metre. This unit has been under consideration for some years and has been provisionally adopted by several writers in this country and in Europe.

OBSERVER K. (INCANDESCENT LIGHT).

Observations.	No.	Sum.	Mean.	Residuals.		Sum of Residuals.	Mean Residual.
8 5	13	132.4	10.184	....	1.684	10 0.16	0.77
9.6	..	....	....	....	0 584	....	....
9.4	..	....	....	....	0 784	....	....
11.4	..	....	....	1.216	....	....	....
12.2	..	....	....	2.016	....	....	....
9.6	..	....	....	....	0.584	....	....
9.2	..	....	....	....	0.984	....	....
10 2	..	....	....	0.016	....	....	....
10.5	..	....	....	0.316	....	....	....
9 8	..	....	....	....	0 384	....	....
10.2	..	....	....	0.016	....	....	....
11 2	..	....	....	1.016	....	....	....
10 6	..	....	....	0.416	....	....	....

Result, 10.184; mean error, 0.77 (7.56%).

OBSERVER W. A. (DAYLIGHT).

Observations.	No.	Sum.	Mean.	Residuals.		Sum of Residuals.	Mean Residual.
47	13	604.5	46.5	0.5	....	65	5
37	..	....	....	....	9.5	....	....
50.5	..	....	....	4 0	....	....	....
57	..	....	....	10.5	....	....	....
43	..	....	....	....	3.5	....	....
45	..	....	....	....	1.5	....	....
38.5	..	....	....	....	8	....	....
40.5	..	..	....	....	6	....	....
46	..	....	....	....	0 5	....	....
55	..	....	....	8 5	....	....	....
55	..	....	....	8.5	....	....	....
43	..	....	....	....	3.5	....	....
47	..	....	....	0.5	....	....	....
				32.5	32 5		

Result, 46.5; mean error, 5 (10.75%).

DISCUSSION.

Mr. Caryl Haskins doubted if the permeability of the translucent screen would be the same for rays of light of different colors, and thought it would be greater or less, as the rays are more or less white or red. He said that the human eye certainly appreciates one more than another in different individuals, some appreciating the lower rays more quickly than others, while some people see better in the dark than others.

Prof. Elihu Thomson: The question of the measurement of illumination seems to me to be analogous to the measurement of temperature, largely by the feeling, though, perhaps, not liable to such great errors as might exist in that case. The object of the instrument is undoubtedly a good one, and it is undoubtedly meant to meet that condition which we, as members of the National Electric Light Association, often have to meet—a dispute as to whether a certain light is doing its duty, not whether the light up there or somewhere else was producing a certain illuminating effect, but whether it is actually delivering at the useful point on some surface, and of a quality which would enable us to read by it. Undoubtedly that is what we are driving at when we hang up a lamp. We do not care anything about the light up there; we want to have it here; and if we can arrange some means whereby, by placing an instrument here, we can get an exact idea of the illumination, measured by the degree of visibility, perhaps, then we have certainly accomplished a good object and a valuable one. It occurs to me, however, that the question resolves itself into a physiological question. We know perfectly well that visibility depends on contrasts. If we turn rapidly from a highly illumined surface and then down at some other object, we find that we have to wait a little while before the eyes will respond, and it depends altogether on the degree of brightness of the object toward which we looked how long we will have to wait. It is difficult to say how long we shall have to wait before the effect of that light in our eyes is removed absolutely. That is an uncertain question. I simply state this as bringing out one of the points in my mind. The object of our coming here is to get at the truth and know where we are on these questions; it is not to make captious criticisms, but to know where we are. There is a difference between visions—I think the rate at which an impression is made, and the legibility of an impression, are two different things; sometimes we get an impression quickly, and at other times we get an impression slowly. It would hardly be proper to measure everything by legibility, depending on time of impression, because the illumination as to rate may come in there. I think the eyes are different. I think it has been recognized that there is a different rate of impression—what we may call continuity of impression.

Another criticism I would make is that the printed slip that you would use in this instrument, after you have used it for a while you get to read it more easily than at first. If you are going to change that printed slip every time, you may change the character of the surface, you may have surface not so white or a little different, and you cannot be sure you are getting the standard surface. Every one knows if he has read a thing he can read it much more easily if he has to read it again and knows what is there. The effect of imagination comes in—that is another physiological action which has to be counted on. It is a question to my mind, in an instrument of this kind laid aside and not used for a time, whether the paper will maintain its integrity as a surface for receiving and diffusing light. We know that it is darkened by age. I think it would certainly be required that we should use some material like porcelain, like a watch face, absolutely permanent, if we employed the method at all.

There is another question. Is it true that with different individuals the iris opens or responds equally? do the eyes have the same aperture to receive light? I have my doubts so far as my observation goes. In the eye of a child the iris opens wide, but with an older person the eye is not so flexible; in fact, it may finally become partially fixed. It will not give the same aperture of illumination; the diaphragm is smaller and does not respond so easily. In certain forms of incipient disease the first indication is that the iris does not respond easily. What percentage of difference that would make in reading anything, or seeing anything with the eye, that was at all illuminated, I do not know; that is simply something which I put out as a suggestion. But it is a matter of my personal observation that if I am looking in a darkened room I see all the objects for a little while, they disappear, and then I see them again, as if the sensitive material of the eye was renewed in gushes. There is some peculiar connection of the sensoria which, as it were, brings on a wave of sensibility, then wipes it out, and then brings on another wave.

Then comes the question of color blindness in people. I have met a number of people subject to color blindness, not sensitive to the red rays, some more than others. It is well known that the power of vision to the higher rays is very different to that of the ultra-violet rays; some can see the lavender in the spectrum, others scarcely at all. It happens that at the extreme violet part of the spectrum there is not a great amount of useful illumination, but still there is some, and it might make a difference in some cases. I simply bring these points forward as indicating that we find it necessary, before adopting a method of this kind, to compare the results of a large number of observations to find out whether there

was a difference to be noted, or whether we could rely upon a fair average result. Ten per cent. out would not bother us very much, and, perhaps, all these errors combined might, if we used due precautions, be included within the 10 per cent. Then the instrument undoubtedly would have my unqualified endorsement.

Mr. Jas. I. Ayer: The adoption of an instrument of this character would seem to me, as expressed by the other speakers, to be a thing which should receive a great deal of consideration. Aside from the different physiological results which might accrue from the difference in the eyes of different people, a standard instrument that was brought into use and put into the hands of people who are often endowed with power to determine matters in dispute, but frequently work very serious hardships, not the least of the points involved in a thing of that kind is the integrity of the persons using it. The point made by Prof. Thomson about the familiarity with the letters, where imagination comes into play, is a very important one. We had a case of this kind, where there were produced a number of sheets of paper with varying sizes of letters printed on the sheet. A committee was selected who remained with their backs toward the light so as to avoid affecting the visior by looking at the lamps, and each one would walk a definite distance away and then endeavor to read a certain number of lines aloud. We found variable results. One man would read line number two at 200 feet, and another, line number three the same distance, and so forth; but as we proceeded we found a change. We found that the man who first could only read line number two 200 feet away, could read line number three, the latter being a finer print. The men, I think, were naturally unbiased in the matter, but they gradually became familiar with the printing. To overcome this familiarity, at the suggestion of the chairman of the committee, we had printed a series of slips with a line of Volapük, a half dozen words on each line, and it was practically impossible to memorize it, and after an evening's work of several hours we found this relation continued to exist throughout the whole evening. The conditions did not change, the characters could not be so easily memorized; giving abundant evidence, to my mind, that it is very easy to have the imagination come in as an element to determine anything you have as a fixed standard to judge by.

Mr. Kennelly: The first point raised by Mr. Haskins is a question as to the relative sifting power of the translucent screen for various colors of light, but it seems to me—and I think it will seem to you on reflection—that that difficulty is entirely eliminated by the very method employed in calibration. If we have anything in light, if we have any basis in applying any value to it, it is a standard of intensity; that basis may be a standard candle, that basis may be a Hefner-Alteneck lamp—whatever these values may be, they are standard and recognized as such. If, with a definite standard to take the instrument at measuring distances from that standard, you have a definite known illumination, and if you calibrate and mark off the scale of the instrument to what that illumination must be, you have eliminated for that character of light all possible questions as to the degree of sifting of the translucent material. It is true that the argument does not hold so soon as you change the character of the light. The illumination measured on this table by incandescent light, if an incandescent lamp had served you as the standard, and a calibration was made by an incandescent lamp, it might cease to be the true illumination measured by oil or arc light; but by actual trial we have found that the error which may be induced by the variation which must exist, by the absorption of material for different colors, is too small to be noticed. A sixteen candle-power lamp measured for its intensity of candle power by the instrument in its use as an indirect photometer, agrees with the measurement obtained by reckoning it from calibration obtained by a standard candle, within the limits of probability of the instrument.

In regard to what Prof. Thomson has so eloquently explained with reference to the unfortunate power of our eyes, I grieve that our eyes should be open to such grave impeachment, and in fact I am only glad, after reading of the troubles to which we may be liable, that we have anything which we may call eyes at all. No two eyes see alike, and it is not possible to get an instrument, based on the agency of the eye, to be absolutely correct; but, on the other hand, I am pleased to remember that our eyes have some definite value, and just in so far as our eyes are perfect and normal, just in so far can we conduct the measurements relied upon.

In regard to the figure in the illuminometer, there is no doubt as to whether you know it or not. They are simple figures consisting of five characters, and after you once read it you can scarcely fail to recollect what you read. You know very well what the characters are. You simply endeavor to bring them down until you cannot read them. All these errors which are inherent in any apparatus involving the eye have, after all, a certain limit. I will ask any gentleman present if he can tell me what the illumination upon the surface of that table is, within 50 per cent. I will feel quite pleased if any gentleman can tell me within 50 per cent. what it is. We can measure it within 10 per cent. Surely you are glad to have something to tell you within 10 per cent., if you cannot estimate it within 50.

Prof. Houston: I do not think it necessary to carry out this discussion very much longer, though there are one or two points I would like to discuss in answer to the objections that have been raised here—happily by gentlemen who have preceded me. As to the permeability of the secondary illuminator, as questioned by Mr. Haskins: yes, there may be some question as to its being more permeable to a light of certain frequency than another. I think the explanation by Mr. Kennelly of the methods we adopt in calibrating the instrument obviates any objection that may have existed in that direction. As to the question ably raised by Prof. Thomson, it is unfortunately true that there are limitations to all our senses. These limitations are by no means restricted to the eye; they apply to all our senses; and, to a certain extent, the objections which the Professor has so pertinently brought, as limiting the use and applicability of our instrument, must necessarily apply to any instrument of physical research that can be employed. As to how long one should wait until the eye gets rested after reading the instrument, I think the answer is, fairly, he should wait until he can read the test object inside the instrument. He cannot get that in a moment. It may require a motion of the slide shutter, so that his eye will be exposed once or twice to an increasing and a decreasing illumination and by the time that he can read it I think his eye would be a fairly normal eye; and in the same way, that would answer, I think, the objections as to the time of legibility—as to whether we can see a thing rapidly or not. After all, the use of this instrument only requires that a person shall be able to do what his training has taught him to do since he first opened his eyes in this world—to be able to see an object with fair distinctness, that is all. There is very little judgment required, except that he must determine whether or not he can see well enough to do a certain thing, that is, to read. As to color blindness, that does exist; but I question very greatly whether the doctors, in their interest in physiological research or their willingness to-day that certain people on the railroads should not be in charge of locomotives, may have permitted their judgments to be warped. I do not believe that color blindness exists in anything like the extent it is stated to. If it does, this instrument is not limited to be used by five or six people, but it may be used by anybody, and in this way the actual facts can be known.

Electrical Carriage Traction in France.

A carriage has for some time been used in Paris whose motive power is supplied by Tommasi accumulators, the battery being contained in a box placed under a seat and connected with a small motor underneath the carriage. The outfit is completed by a controller and a brake, to which the circuit switch is connected. The plates of the accumulator consist of a celluloid envelope perforated with numerous small holes and filled with active material; in the centre is a lead core serving solely as a conductor and not as a support to the active matter, as in other systems of accumulators. The plates of the same sign are soldered to a connecting bar, and insulated from neighboring electrodes by vertical celluloid strips. The cells are of wood with a double lining of celluloid and closed at the top by a transparent cover tightly sealed.

No difficulty results from the motion of the carriage, and the battery can discharge without injury at extremely high rates.

The complete battery equipment of the carriage is composed of 21 cells, each weighing 28 lbs. and enclosed in seven boxes, three cells to the box. The cells are mounted in series and often discharge at a mean rate of 100 amperes and 40 volts at starting, and on high grades the discharge rate attains 200 amperes. Under these conditions the battery will supply power for one and one-half hours, which corresponds to a capacity of 16 ampere-hours per pound at light discharge, 23 ampere-hours at a mean rate of discharge, and 32 ampere-hours at a maximum rate. Under less severe conditions the capacity is much higher than this, say 47 ampere-hours at the rate of one ampere per

hour, 38 ampere-hours at the rate of three amperes per hour and 32 ampere-hours at the rate of six amperes per hour. The total weight of the carriage with two passengers is about 2,600 pounds, and its speed about 12 miles an hour. The carriage starts freely and can be brought to a standstill almost instantaneously. It runs noiselessly, and its control is extremely simple. An interrupter permits the battery to be completely cut off from the motor during a long stop of the carriage.

Candle Power of Arc Lamps.

To the Editor of The Electrical World:

Sir:—I have read with interest the article in your issue of Feb. 23, by Dr. Stine, on the subject of candle power obtained with various carbons. From his premises his conclusions are logical, but I think he is in error in assuming that under normal conditions the light of the arc lamp, or any considerable portion of it, comes from the arc stream itself. He says: "The candle power of an arc (lamp) depends on the amount of carbon vapor which it contains." If his assumption were correct, the maximum candle power would be at the horizontal, since the depth of the crater, especially with solid carbons, is very small as compared with the length of the arc, and the crater wall interferes but slightly with horizontal radiation from the arc stream. The well-known candle power curves show the maximum at say 45 degrees below the horizontal, and in the case of the alternating arc with two cored carbons, there is a maximum both above and below the horizontal. In both cases at the horizontal, where we get the greatest illumination from the arc stream itself, the total candle power is small. It is at the surface of the crater that the greater portion of the energy of the arc is expended in volatilizing the carbon to furnish the vapor necessary to conduct the current across the gap; it is here that we find the highest temperature, and from the surface of the crater comes by far the greater portion of the light. That from the negative is largely reflected from the positive, and that from the arc stream is small. That from the crater, emitted by carbon at its temperature of volatilization, most nearly resembles sunlight in quality, while that from the arc stream is blue or violet; hence a long arc, in which a greater proportion of the light comes from the arc stream gives a violet tinge to the whole, though an opal globe shows the violet rays confined to a narrow band near the horizontal. The amount of carbon vapor present has very little influence on the candle power, for carbons made with a soft core for the express purpose of supplying carbon vapor to the arc, give a lower efficiency than solid carbons. (See Dr. Stine's published tests, if confirmation is required.)

The efficiency of any form of carbon as an illuminant rises with the temperature of the incandescing carbon. An incandescent lamp in which the filament is heated nearly to the point of destruction by vaporization shows an enormously increased efficiency. The arc is more efficient than the incandescent filament because of its higher temperature. In the arc the efficiency rises with the temperature of the crater. A highly refractory form of carbon, such as petroleum coke, gives a higher efficiency than a form which volatizes at a lower temperature, but carbons to burn at say 28 volts, as in alternating lamps, must be made of a less refractory material than those made to burn at 45 or 50 volts with the same currents. If a carbon adapted to a 28-volt lamp be burned at 45 volts, it will give less light at the same wattage than a carbon which would hiss at 40 volts but burns steadily at 45. Yet the former carbon is usually harder than the latter, but is made of a less refractory material, and at 45 volts gives off an excess of carbon vapor, with resultant flaming. I think Dr. Stine lays too much stress on softness. There is little danger of a molded carbon being too hard for a current of 9 or 10 amperes. He attributes excessive hardness to carbonization at too high a temperature. As a matter of fact, an over-carbonized carbon is soft. An underbaked carbon may be hard and to the eye appear very well, and yet hiss at 30 volts and flame at 55. I have seen such a carbon rebaked at a high temperature for an hour, and the hissing point thereby reduced to 42, and the flaming point raised to 60. In this case the hard carbon was objectionable, but the cause was the opposite of that indicated by Dr. Stine. If it were practicable to bake carbons at a temperature near that of the crater, we should thereby increase their efficiency. The introduction of hydrocarbons which Dr. Stine advocates as a correct principle, would be a return to the conditions of underbaking, as it is the presence of hydrocarbons which gives the objectionable results indicated above.

Finally, as to long-life carbons, passing over those in which life is lengthened by a heavy coating of copper, or still worse, of zinc or nickel, which forms a shell around the arc, shutting the oxygen out and the light in, the perfectly baked carbon, whether hard or soft, disintegrates less, and therefore gives better life as well as better light. Dr. Stine's point on size and uniformity of grain is well taken and strikes at a very common error. But he might have carried the point further, for just such a grain as he adovcates gives the best life.

The prime consideration is that a carbon should be adapted to its particular work. For small currents a rather soft carbon is advantageous, and for low-tension sytems using 18 or 20 amperes, forced carbons are best adapted, both on account of hardness and of the peculiar arrangement of the grains. Dr. Stine mentions the influence of the crude material, and I regret that he has not gone more deeply into this, as it is of great importance, considering the variety of conditions which are now met with.

WASHINGTON, PA. B. H. BLOOD.

Electrical Consonance.

To the Editor of The Electrical World:

Sir:—I feel very much flattered that Mr. Steinmetz has considered it worth his while to translate my article on "Electrical Consonance" into the language of electrographics. It gives me much satisfaction to know that Mr. Steinmetz has not detected a flaw in my reasoning and that the main features of this reasoning can be represented graphically by the extremely simple diagrams given by Mr. Steinmetz in the last issue of your esteemed journal. I wish, however, to warn your readers against a possible inference which they might draw from Mr. Steinmetz's extremely simple graphical discussion—the inference, namely, that the graphical method is superior to the analytical in studying alternating current phenomena. A closer examination of this particular case will reveal the non-permissibility of such an inference; for although Mr. Steinmetz's diagram contains the main features of my article, viz:—(a) distinction between electrical resonance and neutralization of the apparent self induction of primary circuit by means of a condenser in the secondary, and (b) the existence of two distinct components in the secondary currents at which this neutralization takes place,—still, that is by no means all that I had to say in that article. In fact, the main point in my theoretical discussion was to bring out the complex manner in which the various physical constants of the two circuits enter into the quantitative relations which underly the phenomena of electrical consonance. I think that in this point I have succeeded very well, so well, indeed, that Mr. Steinmetz has considered it desirable to translate my article, minus the general complicated equations, into simple graphics. But I wish to assure your readers that if Mr. Steinmetz had seen fit to follow me to the bitter end, his graphical method would have resulted in extremely complex diagrams and would, therefore, have succeeded even better than my analytical method did in showing how complex are the relations underlying the phenomena of electrical consonance.

Without a knowledge of these very much involved equations it is impossible to find out the most effective conditions under which electrical consonance can be studied experimentally. I wish, however, to emphasize the fact that it is far from me to undervalue the strong points of the graphical method of which Mr. Steinmetz is an admirable advocate. There is room for all correct methods in the wide regions of the beautiful science of electricity.

NEW YORK, N. Y. M. I. PUPIN.

Perhaps Not Sanguine Enough.

According to the Philadelphia *Ledger's* correspondent from Harrisburg, concerning the doings of the State legislature, it has been predicted that in the year 1899 the legislators will be taken from Philadelphia to Harrisburg by trains operated by electric energy. How this exact date has been determined we do not know, but we venture to predict that on those existing steam roads on which there is a very large passenger traffic between two large cities, not much over 100 miles apart, the substitution of electric traction will be made before that year. The change is so easily made, and the advantages and economy can doubtless be shown to be so great, that it will probably require only a few practical demonstrations, which are now beginning to be made, before the number of roads to take advantage of this improvement will increase in geometric ratio.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

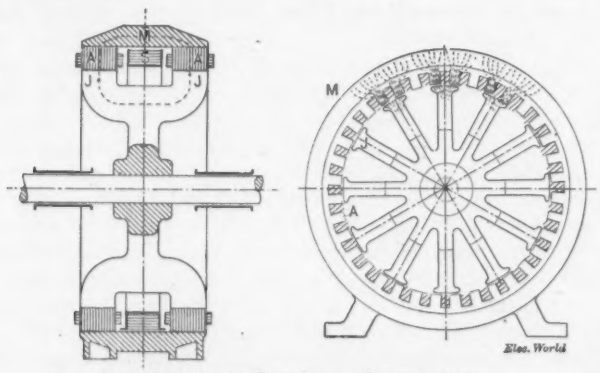
BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors, or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 922 Chestnut street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French, or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

DYNAMOS, MOTORS AND TRANSFORMERS.

Alternators.—In a paper by Mr. v. Dobrowolsky reprinted in the "Elek. Zeit.," Feb. 7, he describes and illustrates a type of alternator and three-phase generator made by the General Electric Company of Berlin. He points out the advantages of using a single field coil for the multiple magnets, a system first used by Klimenko, and subsequently by Mordey and others; the machines are similar to those made by Stanley in this country; he believes this system will gradually be universally adopted; the advantages are, cheap excitation both in the copper required and in the energy consumed, and a very low fall in voltage, as the field may be made very strong and the armature windings few without increasing the dimensions of the machine abnormally; there is furthermore only a very small hysteresis loss and the efficiency even at small loads is very high; there is another advantage, that with a proper design the magnet coil may be stationary, while only the magnetic cores revolve. The general design of one of the machines is shown in the accompanying figures. The design is equally applicable to three-phase machines. He gives the data of a 400-hp three-phase machine. In conclusion he discusses the much vexed question of the best loss of voltage in an alternator; he ridicules the suggestion to make the self induction so great that on short circuit the current would not increase more than 50 per cent. and suggests that they had better be protected, like continuous current machines, by fuses or automatic disconnectors; although Mordey demonstrated practically that both the resistance and the self induction should be as small as possible, there seems to be still a discussion concerning it; he believes that constructors will soon agree that practical experience has shown that Mordey is correct. The loss in voltage is very objectionable when there are motors in circuit; if for the lighting current the loss in voltage is 4 to 5 per cent. it will, for a full load of motors, still be 15 to 20 per cent. In the above he combined the choking action and the armature reaction, which is not quite correct but the two actions are very closely related.



ALTERNATING CURRENT GENERATOR.

Alternators in Parallel.—According to the Lond. "Elec.," Feb. 15, the trial at the Coatbridge Station in which certain alternators (the particular type is not mentioned) were driven by gas engines and connected in parallel has proved that that system is untrustworthy and defective and it has been decided to run the station by steam.

Theory and Properties of Synchronous Motors.—An article by Mr. Blondel is begun in "L'Ind. Elec.," Feb. 10; he intends to give a sufficiently elementary discussion which will enable those who are familiar with graphical calculations to study the properties of these motors in detail; it does not admit of being abstracted.

Dynamo with a Single Bearing.—A well illustrated description of a machine of this kind made in France is given by Mr. Girault in "L'Ind. Elec.," Feb. 10; he also discusses the requirements for a cheap machine intended for moderately small outputs.

Small Dynamos.—The article on the construction of a small dynamo is continued in the Lond. "Elec. Rev.," Feb. 15, in which a number of illustrations with dimensions are given of a Manchester type dynamo.

Core Losses in Transformers.—The first part of a paper by Mr. Wilson is begun in the Lond. "Elec.," Feb. 15; the object of the paper is to ascertain whether the energy dissipated by magnetic hysteresis and induced or eddy currents combined is greater when the transformer is in action on open circuit than when loaded, or in other words to find the effect of the current in the secondary coil upon this dissipation of energy. The researches were made with a 2-kw Westinghouse transformer of an old pattern; the present portion contains the results of a test but no general conclusions.

Transformer Chambers.—Two types now in use in London are well illustrated and described in the Lond. "Elec.," Feb. 15.

LIGHTS AND LIGHTING.

The Electric Arc.—Mrs. Ayrton's article is continued in the Lond. "Elec.," Feb. 15. A number of interesting curves and deductions are given; the deductions do not admit of being abstracted; they will doubtless be found of great value to those working with arc lamps. Among other things she shows that a change in the constant value of the voltage from say 46 to 41 volts alters entirely the way in which the current varies with the length of the arc, increasing in the former case with the length of the arc and decreasing in the latter; additional experiments were made to confirm these conclusions. A set of curves are given connecting the apparent resistance of the arc with its length for various constant voltages and it is shown that as the arc gets nearer to the hissing point the apparent resistance approaches a constant, equal to from 1 to nearly 3 ohms; from this she deduces the important law "the apparent resistance of the arc when it is on the point of hissing is a constant for given carbons, and independent of the length of the arc;" this resistance is greater the smaller the carbons. A complete investigation was made of the variation of the voltage with the time that has elapsed after the arc was started or the current suddenly changed; the results show that the difference of potential becomes a constant for a given current and length of arc; the cause of the variation and the effect of a cored or uncored positive carbon are discussed; a true arc 3 mm in length can be maintained silently at least for a short time with a voltage of only 16 which is due by the positive carbon being cored.

Holophane Globes.—The Lond. "Elec. Rev.," Feb. 15, contains a well illustrated article by Mr. Blondel in which he describes the principle and construction of the holophane diffusing globes (see Digest, Nov. 10) invented by himself and Mr. Psaroudaki, gives their history and shows the difference between them and the Trotter system, which is chiefly in the fact that they are luminous over their entire surface and that the flutings are both refractory and reflecting, the latter predominating. Illustrations of forms adapted to incandescent lighting and Welsbach lamps are also given.

Globes.—Mr. Uppenborn in the "Zeit. Fuer. Beleucht.," Jan. 30, gives the results of some measurements recently made in Munich below an arc lamp containing an opal globe and below another containing a 12-sided reflecting and refracting globe recently introduced by Schuckert, showing a considerable increase in favor of the latter; the measurements were made on the street with a Weber photometer; the illumination below the lamp was considerably greater but at the expense of that some distance off.

Lighting.—In an article by Mr. Hanchett on electric construction in "El. Power" for February, he gives some practical hints regarding the distribution of lights in interiors giving a table which may be of some use, containing the number of square feet per 16 cp lamp, for different interiors; he discusses the inverted arc lamp, which he recommends very highly.

Church Illumination.—An illustrated article by Mr. Bernard in "El'ty," Feb. 20, describes some of the lighting effects in some New York churches.

Incandescent Lamp.—"Cassier's Mag." for February contains an illustrated article by Mr. Cuntz giving a history of the Edison lamp and an account of its manufacture. He states that to-day there are 11,000,000

lamps in use in the United States and nearly 25,000,000 in the whole world.

POWER AND HEAT.

Transmission Plant at Locle and La Chaux-de-Fonds.—A description of this plant is published in the "Elek. Zeit.," Feb. 7; it is of special interest because the continuous current is used. The dynamos, each of 1,800 volts and 150 amperes, are driven by turbines and are all connected in series, the maximum voltage for the full power being 14,400; the regulation is affected by altering the speed of the turbines; the length of the high tension circuit is 28.8 miles; the full voltage exists between the magnetic windings and the earth and the machines are therefore very carefully insulated, including an insulated coupling where they are connected with the turbines; no trouble has been experienced. The power is used partly in one of these towns and partly in the other.

Egypt.—A brief account is given in "L'Elec.," Feb. 16, of the plant proposed by Mr. Prompt for utilizing the hydraulic power of the Nile and distributing it electrically for irrigation purposes.

Arc Welding.—An abstract of a recent paper by Mr. Foster is published in the Lond. "Elec. Eng.," Feb. 15, with illustrations; the system used in two establishments in England is described, also a number of repairs which have been made very successfully by this method: one is that of a connecting rod, another that of a worn-out wobbler end of a roll for a rolling mill, and of a pinion, and another is the welding of two steel eccentrics to an old crank shaft. In one of the systems used a series of accumulators is permanently connected with the dynamo, the welding circuits, consisting each of the arc and a resistance, are connected in parallel; in this system the capacity of the dynamo is about doubled. In the other system there are no accumulators; the efficiency is not so high, but the first cost is less and the apparatus is more portable. When iron or steel are welded the carbon is usually made the negative pole, but for lead and some other metals the carbon is made positive. The system has been considerably improved the last few years.

Elastic Couplings for Gas Engines.—"L'Ind. Elec.," Feb. 10, contains a long article of a mathematical nature by Mr. Guillaume. The "Bul. Soc. Int. Elec." for January contains a mathematical discussion by Mr. Blondel; another by Mr. Arnoux on elastic coupling and the phenomenon of resonance; another of some length by Mr. Desroziers including a number of diagrams.

Electric Motor in the Machine Shop.—A paper by Mr. Richmond, read at a recent meeting of the American Society of Mechanical Engineers, is abstracted with the discussion, in the "Eng. News," Feb. 21 (see also Digest, Jan. 12). A very great advantage has been found in the substitution of motors for engines in rolling mills, dockyards, etc., as was to be expected; he refers to a recent paper by Selby-Bigge (see Digest, Jan, 5 and June 23), in which he instances a case where six steam engines aggregating 94 hp were replaced by motors aggregating 29.5 hp. He divides the applications of motors into the three well-known classes and refers to existing installations; in one case 9 motors aggregating 75 hp were installed, the dynamo being 40 hp, which was found by experience to be sufficient, although at times it is severely taxed; the average indicated power supplied during a six-weeks test was 24 hp, or about 14 hp supplied to the dynamo. He refers to two papers which have been reprinted and published by the C. & C. Co., one by Castermans and the other by Melotte, referring to the government rifle factory at Herstal, Belgium, which he said ought to be in the hands of every one interested in this subject. He gives the statements from each of these regarding the advantages of using electric motors in such factories, all of which have been frequently given before and are already well recognized. In conclusion he states that the real question is, will electrical transmission enable one to turn out work at less cost? He believes that the cost of the motive power in a "factory" is not much more than 1 per cent. of the wages, etc. (but this varies greatly with the kind of factory), and if, therefore, it could be shown that the adoption of electrical transmission would increase the production of each man 1 per cent. only, it would compensate for the doubling up of the cost for motive power, but if it involves a loss of only 1 per cent. in the efficiency of the workman and machine, it is frivolous to insist upon the relative advantages of the difference between the transmission efficiency, since there is an absolute loss equal to the total cost of the motive power. In the discussion Prof. Crocker said that existing figures cannot be looked for now as they will be quite different in different cases; he claims, however, that the success or failure will be decided by the question of whether it is satisfactory in the long run and whether the superintendent and workmen like it; the greatest advantage is that the shop is clear of belts and shafting; he believes that the average load in shops is not over 30 per cent. of the total capacity; there are also many times when the shop is running every light. Mr. Oberlin Smith believes that the advantages, other than in the transmission loss, are such that even now it will pay to equip machines with motors as fast as it can properly be done; the clear space obtained by avoiding belts enables one to use cranes and enables the shop to be better lighted; the speed is also under control; a sudden excessive overload will do no more harm than blowing the fuse, whereas with a belt driven machine serious injury may arise. Mr. Fay states that after serious consideration he concludes that it is not always proper to put a motor on every machine, the efficiency of very small motors is not high enough; for small machines, several are connected to one motor; he refers to a motor built by his company which will give a difference of speed of 100 per cent. without any sparking whatever, which is accomplished by "field commutation." Mr. Platt called attention to the advantages of the modern slow speed motors. Mr. Davis referred to a very satisfactory system at the Southwark Foundry in Philadelphia. Mr. Henderson stated that the arrangement of the windows and trusses of a roof could be made much more satisfactory if no account need be taken of shafting. Prof. Crocker favored 250 volts on the ground that carbon commutator brushes have not sufficient conductivity for 110 volt circuits. Mr. Towne called attention to the fact that there are many factories in which much larger amounts of power are used than in machine shops and in those cases an economy of power would be of greater importance.

Direct Driven Machines.—"Cassier's Mag." for February contains an article by Mr. Hall including some illustrations of a large direct driven lathe and drill. He calls attention to the well known advantages of direct driving and gives the results of some measurements made with some lathes.

Efficiencies of Mechanical and Electrical Machines.—Mr. Willis in "Cassier's Mag." for February discusses the efficiencies of boilers, engines, dynamos, motors and lights, making some interesting deductions. An ordinary engine and boiler waste 96 per cent. of the energy of the coal, and the best waste 92 per cent.; the light efficiency of the incandescent lamp he gives as 9 per cent. (is this not much too high, except possibly for a much overworked lamp?) making the total efficiency between coal and light six-tenths of 1 per cent; the efficiency of the arc light he gives as 35 per cent. (this also seems much too high), making a total efficiency of 2.1 per cent; with steam generated electric energy used for heating the waste would be 94 per cent., the amount of coal required would therefore be 94 per cent., while in an ordinary stove it is probably about 45 per cent.; the amount of coal would therefore be nine times as little.

Transmission Plant at Pordenone.—"El. Power" for February abstracts an illustrated description of this plant from an Italian journal; two continuous current generators of 140 hp each are connected in series, as also the 2 motors, 2.5 miles distant, a third or neutral wire being used in order that the motors may be run independently; the total efficiency is given as 80 per cent; the voltage of each machine is 3,000, and it is believed to be safe to increase it to 4,000.

Niagara Power Plant.—A descriptive article by Mr. Perkins, with some illustrations, is published in the "West. El.," Feb. 23.

Heating Apparatus.—In the "Elec. Eng.," Feb. 27, Mr. Leonard describes and illustrates his apparatus for various purposes in which a small amount of heat is required. He shows the advantages of encouraging the use of such apparatus to level the load line of a station; the reasons why so little of this kind of apparatus has heretofore been used, are that much of it did not work economically, that its first cost was too great, that the current was too great to allow it to be attached to a lamp socket, and that the cost of the energy was too great; he believes that all these objections have been overcome by his apparatus; the resistance material which he uses has a very high fusing point, is surrounded by a thin coating of almost infusible material and is embedded in a closely applied mass of metal; the wire cannot combine chemically with the surrounding medium and is hermetically sealed, it can therefore be operated at a red heat. A storage capacity for heat is not only unnecessary but extremely detrimental and the radiation loss becomes great; in his apparatus the working surface is as small as possible and has the least possible amount of material with the lowest specific heat. A small soldering iron requires 50 watts, while as heretofore made they required 400 and more; other small heating apparatus is shown, requiring but 150 watts. He gives a very useful table of a large number of equivalents of power, work, and heat units.

TRACTION.

Conduit and Overhead Systems.—A long illustrated paper by Mr. Gerard is contained in the "Bul. Soc. Belge. d'Elec.," June-September; the greater part of it is devoted to descriptions of conduit roads; an illustration is given to the side trolley system used in South Staffordshire, Eng.

Accumulator Traction.—According to a note in the "Elek. Zeit.," Feb. 14, a number of serious difficulties were encountered in the Waddell-Entz system recently started in Hagen, Germany, necessitating a number of changes, but it is claimed that they have now been overcome.

Traction.—In a continuation of his serial in Lond. "Engineering," Feb. 15, Mr. Dawsen discusses the return circuit.

Trolley System Applied to Steam Roads.—The "Elec. Eng.," Feb. 20, contains several further communications regarding this subject (see also Digest Feb. 23). Prof. Anthony believes that 1,000 and even 1,500 volts can be safely used; series wound motors can be built for 1,000 volts; 4 to 5 cars drawn by an electric locomotive will best fill the requirements for long express run services; he calls attention to the great want of maintaining a high efficiency of the motor at varying speeds; he men-

tions a theoretically correct method which has been proposed, but whether it would be successful in practice is uncertain; in this the motor acts through a liquid gearing in the form of a pump driving liquid motors on the car axles; by using one or several motors the speed would be varied but the efficiency would remain the same; the Leonard system is economical, but a 500-hp locomotive must be equipped with 1,500-hp electrical machinery. At present alternating current motors are not suitable, they do not lend themselves readily to varying speeds and cannot be handled with the same facility. A 1,000 volt three-wire system using the rail as the balancing conductor he considers would be best; for traffic requiring frequent stops motor cars should be used and for trains of 5 or 6 cars either a locomotive should be used or else car motors all handled from one point; trolley wires should be overhead as they would be in the way of the section men if placed on low posts. He believes there is no doubt that electric traction is more economical than steam locomotive traction; one great advantage in the change is that single cars run at frequent intervals accommodate the public far better than long trains at long intervals. Mr. Arnold approves of electric locomotives rather than motor cars; the direct current constant potential system is the only one that has proved itself practical; the voltage may be at least 1,000 and will probably be increased later on; the three-wire system is best when there is a frequent service but is not practical for the long lines with few trains. Mr. Short believes the time has now come when steam roads will be changed to electric roads and that it will be more economical as far as operation is concerned; his company is at present filling several orders for such roads; they use long double truck cars for speeds of 35 to 40 miles an hour with two 50-hp motors; or, when trailers are used, two 100 hp motors on the combined baggage and smoking car; for long trains it may be advisable to use a locomotive; for a moderate amount of power he believes the overhead system best; the three-wire system can be used to advantage where there is sufficient traffic; with heavy locomotives and trains it will be a serious problem to place the conductors where they will do little harm and still be heavy enough mechanically; he does not believe it will be safe to place them near the surface of the ground unless they are inclosed.

Electric Traction on Steam Roads.—According to the "St. Ry. Gaz.," Feb. 23, the cars on the railway connecting Burlington and Mt. Holly, N. J., on which electric traction is to be substituted for the present steam traction, will be almost as large as the standard passenger coach and they will be equipped with two motors of 75 hp each, designed for a speed of 50 miles an hour; trailers may be used; the intention is to give a frequent service at high speed; steam locomotives will probably be used for hauling freight.

Boston Subway Commission.—A summary of some length is published in the "St. Ry. Gaz.," Feb. 23; it deals almost entirely with the civil engineering features; the total length of single track in the proposed subway will be about 5 miles.

City and South London Railways.—An abstract of the semi-annual report of the company is reprinted in the "West. El.," Feb. 23.

Light Railways.—The "Eng. News." Feb. 21, gives a brief summary of the recent English Board of Trade Report.

Railway Motors.—Mr. Henry in the "Elec. Eng.," Feb. 20, calls attention to some of his patents for improvements in railway motors. In reference to the magnetic brush holder (described in the Digest Feb. 16), he calls attention to the energy lost at the brush contact by friction and finds it to be 20,000 foot-pounds per minute with ordinary motors run at 20 miles per hour with a brush pressure of 12 pounds. To overcome the loss in the short circuited armature coils he connects the commutator segments with the armature windings by means of superficial spring contacts, instead of solder, which will increase the resistance of the local circuits, but the resistance is said to be insignificant for the whole energy. An improvement in the motor fields consists in winding them with a large number of parallel conductors all connected together at one end, the other ends being joined together at the will of the motorman; (this does away with the external resistances but amounts practically to making them of copper and placing them on a field, the advantages of this would therefore seem questionable).

Overhead Trolley Wires in Philadelphia.—From the report of Chief Walker of the Electrical Bureau of Philadelphia the city ducts are occupied to the extent of 5,113 978 feet (or very nearly 1,000 miles) by the four leading trolley companies of that city. He is still of the opinion that the successful working of the underground trolley system is assured; he calls attention to the dangerous features of the overhead trolley, citing the forcible illustration during a recent storm in which the guard wires themselves, which under ordinary circumstances may be useful, became not only utterly useless but were themselves a danger in coming in contact with the trolley wires; they are even a danger when they remain in position, when foreign wires form crosses between them and the trolley wire (would this not be avoided if the guard wires and poles were thoroughly grounded?). The trolley companies in this city now have 16,868 poles.

Conduit vs. Trolley.—Mr. Sach's article is continued in "El. Power" for February. He gives a large number of illustrations of proposed systems including a few that are in use.

Electric Carriage.—A brief description of one operated with the Tommasi accumulators is given in the "Elec. Rev.," Feb. 20.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Calculation of Multiphase Plants.—An article by Dr. Fischer is published in the "Elek. Zeit.," Feb. 7 and 14. He develops the formulas and gives some diagrams to aid in the exact calculation of all problems that arise, with the aid of a very simple formula in which there are no trigonometric quantities. This method has been used for a number of years by the firm of Siemens & Halske.

Central Station Statistics.—Some deductions from the table recently published in "I,'Ind. Elec." (see Digest, Feb. 23) are given in that journal Feb. 10; they refer to France, not including Paris. On Jan. 1, 1895, there were 328 stations, an increase of 9 per cent. over the previous year; the total power was 40,000 hp of which about 25 per cent. is hydraulic power, 56 per cent. steam power, 15 per cent. both, and the rest gas power; the number of stations using hydraulic power is 151 and the number using steam power 119; 260 stations use the continuous current, 73 use the alternating current and three use polyphase currents, corresponding to 70.75 per cent., 27 per cent. and 2.25 per cent. respectively of the total power; the stations using alternating currents have a mean of 145 hp as against 110 for the continuous current stations; 29 are operated by the municipalities, but mostly small, using hydraulic power; 26 are run by gas companies.

Operating Central Stations.—In a paper by Mr. McLean in the Lond. "Elec. Rev.," Feb. 15, on "Some Points on the Working of Central Stations," he reviews the chief reason why electrical energy is somewhat expensive and discusses the means by which a better result may be arrived at.

Rules and Regulations.—The "Elek. Zeit.," Feb. 14, reprints a lengthy discussion which took place at a recent meeting in the German Electrical Society of the proposed set of rules and regulations (see Digest, Feb. 16 and Jan. 12) to guard against fire risks.

Fire at a Central Station.—A recent fire at the Kensington, station, in which accumulators are used, is described in the Lond. "Elec.," Feb. 15.

Electricity in Mining.—A paper by Mr. Corlett is reprinted in full in the Lond. "Elec. Rev.," Feb. 15; he reviews what has been done and considers certain important points; he discusses signaling, telephones, blasting, lighting and transmission of power.

Bremen.—A long well illustrated description is published in the "Elek. Zeit.," Feb. 7; the continuous current three-wire system is used, there being one main station and three sub-stations each with a battery of accumulators, and auxiliary machine and the regulating apparatus; there are only two wires from the main station to the sub-stations, the three-wire system beginning at the latter.

Blackburn.—A well illustrated description of this station is published in the Lond. "Elec. Eng.," Feb. 15; there is little novel in the system used which is of the direct current, low-pressure, three-wire type; accumulators are used.

Chemnitz Three-Phase Lighting Station.—The Lond. "Elec.," Feb. 15, reprints with illustrations a translation of the article mentioned in the Digest, Feb. 9.

Protection Against Lightning.—Some interesting notes by Mr. Wurtz collected during the last summer are published in "El. Power" for February. On account of the existence of nodes and anti-nodes on circuits, many outlets are needed; the question arises, how many arresters will give reasonable protection? To determine this, experiments under actual working conditions were resorted to; a very much exposed trolley line was provided with a large number of arresters, each in series, with a recording device consisting of a piece of tissue paper separating a brass plug from its socket, each discharge perforating it and preferably in a new point each time; after each storm the papers were removed and the records noted; the results have so far been very satisfactory but not yet sufficient to warrant the drawing of conclusions; it may have to be continued two or three years longer; of 22 arresters struck only three have received more than one discharge, which is very significant, showing that the discharges were selective, choosing arresters according to location rather than size of gap; each discharge selects a gap best suited to itself; had any one of the arresters been missing the charge would have been forced to select a more difficult path; the perforations showed a subdivision of the charge; when discharges are heavy they are liable to divide, and if there is only one arrester, the chances of damage to an armature are much greater; it is not unfrequent that the motor armature is damaged by a portion of the very discharge which passes through the arrester; none of the discharges seem to have entered the station. He confidently expects that a continuation of this experiment will substantiate his conclusions and demonstrate the number of arresters required per mile of wire. For 100 miles of feeder and trolley wire, the cost of his lightning arresters at the rate of 4 per mile would be about $2,000, the interest on which is $120 per year, and yet there are plants having no arresters whose direct losses from lightning amount to from 40 to 100 times this sum. He gives some observations made at Bodie, Cal., and a number of curious notes reaching him from time to time, which are instructive.

Lightning Arresters.—A lecture by Mr. Wurtz is briefly abstracted in the "Sibley Jour." for February. It appears to contain little that was not already published in his previous well known papers. He divides the possible ways in which overhead wires may become charged into four groups, by direct stroke, by conduction, by static induction, and by dynamic induction; the first is so very rare that it can be disregarded; experiments and observations lead to the conclusion that it is by static induction that excessive charges are most commonly produced. Lightning discharges vibrate from 10 to 12 times per stroke, the whole time being about 0.001 second; the atmosphere in the neighborhood of such a discharge has its voltage enormously increased.

Philadelphia.—According to Chief Walker's report there are 5,295 electric lamps (probably arc lights only) for public lighting, of which 498 are run by underground wires laid by the city; the city owns the lamps and the contractors furnish the current for 3c. per night less than for lamps erected by themselves, which represents a saving to the city of $5,453, which, together with $4,600, derived from leasing their ducts and conductors, makes a total of 3 per cent. on the amount expended by the city; he recommends that the city should own all the electric substructures; 9,936 lights were deducted from the companies' bills during the year for failure to live up to the contracts, 96 poles and about 70 miles of the wire have been removed during the year; three men and eight horses were killed by the wires during the year. From the figures it appears that Philadelphia has more electric street lamps than New York and Chicago combined and 600 less than those cities together with Brooklyn; it can therefore claim to be the most brilliantly lighted city in the country (but this does not necessarily follow, because the area is very great).

Municipal Plant Statistics.—In "El. Power" for February Mr. Foster gives some deductions for the South Norwalk plant, which supplies 89 arc lamps at an average cost per lamp per night, including interest and depreciation, of 19.2c., which is a surprisingly good figure.

Central Station Economy.—An editorial in "El'ty," Feb. 20, discusses the relative costs of electric and gas lighting and in conclusion recommends a judicious storage of energy in order to level the load line.

Windmill Lighting Plant.—A description of the plant for lighting the residence of Mr. Brush is published in "El'ty," Feb. 20, including a good illustration of the windmill.

Monocyclic System.—The system is discussed unfavorably in an editorial in "El'ty," Feb. 27; it is claimed that it is even more complicated than present systems.

WIRES, WIRING AND CONDUITS.

Telephoning with Uninsulated Wires.—The "Elek. Zeit.," Feb. 7, describes at some length a series of tests made by the German Government with bare wires of different kinds laid directly on the ground. It has been claimed by the makers of bimetallic wires that they require less insulation than those of copper and other materials and the present tests were made to investigate this; the results are given in detail and show that this claim cannot be substantiated in practice.

Cannon Street Explosion.—The first part of the report of Major Cardew is published in the Lond. "Elec. Eng.," Feb. 15.

Wiring.—In an article by Mr. Hanchett on electric construction, in "El. Power" for February, he gives some practical hints and rules for calculating the size of wires, including a table of constants which simplifies the calculations; for lamps taking 0.55 ampere each he gives the rule: Divide the line loss by the lamp feet and the result is the resistance in ohms per foot of the proper wire (by the distance in feet he means the distance to the lamp and not the length of wire).

Subway Cables.—The "Eng. News," Feb. 21, reprints in full the specifications for the electrical equipment of the telegraph cables for the Baltimore subways, including an illustration of the arrangement of the pole terminals.

Telephone Cables with Dry Air Circulation.—The "Elec. Rev.," Feb. 20, reprints from the "Journal of the Institution of Electrical Engineers" for January the abstract of the paper by Mr. Barbaret which was abstracted in the Digest Feb. 23.

ELECTRO-PHYSICS AND MAGNETISM.

Cathode Rays.—In a Physical Society paper briefly abstracted in "L'Ind. Elec.," Feb. 10, Mr. Curie states that he found that luminous rays were not deflected, like cathode rays, by the action of a magnetic field, the rays being perpendicular to the lines of force; when a convergent beam was used, focussed in the middle of the field, a slight lateral displacement of the focus was noticed; he does not think that these negative results show that cathode rays are radiations of a different nature than those of light although they are not favorable.

Action of a Current on Fused Sulphides.—An Academy paper by Mr. Garnier is abstracted in "L'Ind. Elec.," Feb. 10, and "L'Elec.," Feb. 16. In a previous paper he showed that carbon under the influence of a low voltage current is transported from the positive to the negative pole; similar experiments with fused metallic sulphides, in the open air with electrodes of carbon, showed that the sulphur disappeared, forming probably sulphide of carbon, while the conductivity increases.

Electromotive Phenomena of Physiology.—The Lond. "Elec. Rev.," Feb. 15, contains a communication by Mr. Lawrence in which he quotes largely from a paper by Dr. Morton of New York.

Magnetic Pull.—A paper by Mr. Weber from the "Weid. Ann.," Vol. 54, page 30, is abstracted briefly in the "Elek. Zeit.," Feb. 7; it is chiefly of theoretical interest.

Electric Oscillations.—Under the heading of "A Critical Resume" Dr. Pupin in "El. Power" for February gives at some length a review of the recent French book on this subject by Poincaré.

Experiments with Tesla Currents.—An abstract of Mr. Himstedt's paper, published more fully in the ELECTRICAL WORLD Sept. 15, 1894, is published in the "Elec. Rev.," Feb. 20.

Large Gun Magnet.—Some illustrations of Col. King's large magnet (described in the Digest Jan. 19) are published, together with some data, in the "Elec. Rev.," Feb. 27.

Hysteresis.—In his serial on dynamo design Mr. Harrison in the "Elec. Age," Feb. 23, discusses the subject of hysteresis.

ELECTRO-CHEMISTRY AND BATTERIES.

Tin Chromic Chloride Cell.—A Physical Society paper by Mr. Skinner on this cell, based on an account published by Mr. Case of New York, is abstracted in the Lond. "Elec." and "Elec. Eng.," Feb. 15. It consists of a tin plate and a platinum plate immersed in chromic chloride; when the cell is heated to nearly the boiling point of water, chloride of tin is formed at the expense of the chromic chloride and when cooled again on open circuit the reverse change takes place; the voltage at 15 degrees C. was 0.44 and at 97 degrees C. 0.40 as measured by Poggendorff's method, but when connected directly to a galvanometer there was no current at ordinary temperatures but "some current at 100 degrees C." The author prefers to use amalgam of tin and mercury instead of a tin plate; there is no reversed E. M. F. on cooling; he thinks the heat acts by removing an obstacle. Mr. Appleyard thought Prof. Minchin had used tin chloride cells with two tin plates, the cell working only when one plate was illuminated.

Chlorine Cell.—An illustrated description from the Italian, of the Ettore cell, is given in "L'Eclairage Elec.," Feb. 2; it is a modification of an existing type of cell; the electrodes are carbon and amalgamated zinc; the exciting liquid is a nearly saturated solution of chlorhydrate of ammonia, the depolarizer being chlorine in a gaseous form produced by hydrochloric acid falling drop by drop on hypochlorite of calcium (the chloride of calcium of commerce) in a closed vessel connected to the battery box by means of a tube; that which is not used is absorbed by passing through a vessel containing chalk; the box containing a number of the cells is hermetically sealed; the carbons appear to be made in the form of a porous cup containing the liquid and the zinc, the chlorine being in contact with the outside; the advantages claimed are, small dimensions, ease of construction, economy and cheapness of the chemicals, the ammonia solution being continually regenerated; a battery of 20 cells has an E. M. F. of 50 volts and the internal resistance is low; it has been used to light several rooms with 16-cp lamp.

Local Action in Accumulators.—Mr. Fitzgerald states that the local action would increase if the cell is discharged slightly before being allowed to rest for a long time; contact between the electrolyte and the grid should be avoided, which is done by an unbroken layer of the peroxide on the surface, which, however, is destroyed or broken by a slight discharge; attention should also be paid to purity of material, strength of the acid and avoidance of conditions favorable to the production of persulphuric acid.

Theory of Electrometallurgy.—Prof. Crocker's article is concluded in "El. Power" for February. An abstract of the whole article was given in the Digest Feb. 9.

Shafer-Heinemann Accumulator.—The article abstracted in the Digest last week is reprinted in full in "El'ty," Feb. 27.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Alternating Current Curves.—A paper by Dr. Fleming is begun in the Lond. "Elec.," Feb. 15. He calls attention to the importance of finding the curves at the consumer's end of the line as distinguished from those at the alternator end. He describes a simple apparatus devised by himself after considerable experimenting "which enables these curves to be taken with utmost facility at any place and on any circuit;" the success of the apparatus depends entirely on the details of constructions, those interested should therefore consult the original article. The apparatus consists of a simple synchronous alternating current and motor having 8 poles and an armature 6 inches in diameter, the fields requiring about 4 amperes; its shaft contains a contact arrangement with insulating springs set by the aid of a graduated disc; a good illustration is given. To start the motor the fields are supplied with current from a small secondary battery and it is started to rotate by hand with the aid of a thin leather strap running over a pulley. A Kelvin multicellular voltmeter is preferred and is used in connection with a constant E. M. F. in series, obtained from 50 small accumulators, with which arrangement it can be used to measure the voltages over a whole range. He gives the results of a test with a Kapp, a Mordey and a Thomson-Houston

alternator, also with a Ganz transformer; a selection of the curves is promised in the continuation of the article. As the investigations are not yet completed he does not discuss the results, one question, however, has received a solution, it was found that the iron-core loss of a transformer is least when taken on that alternator the E. M. F. curve of which is farthest removed from being a simple sine curve, a result in contradiction to some statements made not long since.

Electrochemical Curve Tracer.—An illustrated description of his well-known system is given by Dr. Janet in the "Bul. Soc. Int. Elec." for January. It is stated to be a simple method offering no difficulties in its application and requiring but simple and cheap apparatus.

Measuring the Armature Loss and Efficiency of Motors and Generators.—The "Elek. Zeit.," Feb. 7, contains a long communication from Mr. Lenz in which he criticises very unfavorably the method of Mr. Grau, which was described in the Digest Dec. 1. He discusses the formula for the calculation of the magnetization energy and shows that the value received will be quite incorrect, and as most of the other quantities are deduced from it, they will also be wrong; he claims that in measuring the field by means of a coil around the armature connected to a ballistic galvanometer the excitation should be reversed in order to get correct results. He concludes that the method has neither practical nor scientific value, for, besides containing a number of errors it is new.

Influence of Magnetization and Temperature on the Conductivity of Bismuth.—A paper by Mr. Henderson from the "Weid. Ann.," Vol. 53, page 912, is abstracted with a table of values in the "Elek. Zeit.," Feb. 7. He shows that the resistance increases in general with the temperature for magnetization below 10,000 units, while the reverse is true for higher field densities; without a knowledge of the temperature, therefore, not even approximate determinations of the field density can be made with the resistance of bismuth wire; such an instrument may, however, be used if combined with a thermometer or a spiral of other wire having a known temperature coefficient. From the table of values the resistance increases more than threefold for fields from 0 to 38,900 units.

Spectrum Photometry.—The description of a new photometer by Mr. Koenig from the "Weid. Ann.," Vol. 53, page 785, is published in the "Zeit. Fuer. Beleucht.," Jan. 30.

Galvanometer.—A four-coil galvanometer made by Nalder is described and illustrated in the Lond. "Elec.," Feb. 15; its design is simple and compact and it is capable of standing rough handling although a high-class, sensitive instrument.

Testing Primary Batteries.—The paper abstracted in the Digest Feb. 16 is given in abstract with some of the illustrations in the "Elec. Rev.," Feb. 20.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Switchboard.—An improvement is described and illustrated by Mr. Engelmann in the "Elek. Zeit.," Feb. 14; he does away with the controlling battery in the common return circuit of a number of lines and thereby overcomes an important objection in the Braun system.

Paying for Telephone Service.—In the "Elek. Zeit.," Feb. 14, Mr. Barth replies to some objections which were made in that journal regarding his system, mentioned in the Digest Feb. 16.

Telegraph Cables in the World.—The "Elek. Zeit.," Feb. 7, publishes a table of the lengths of all the cables.

Lightning and Telegraph Insulators.—The article referred to in the Digest last week is reprinted with the illustration in the "Elec. Rev.," Feb. 20.

Gilgit Telegraph Line.—The article referred to in the Digest Jan. 19 is reprinted in the "West. El.," Feb. 23.

Carbonelle Microphone.—A translation of the article abstracted in the Digest Jan. 12 is published in the "Elec.," Feb. 20.

Pictorial Telegraphy.—In "El'ty," Feb. 20, Mr. Perry describes the well known system of Mr. Amstutz, including some specimens of the work.

MISCELLANEOUS.

Calcic Carbide.—The production of this material (see Digest, Feb. 16) and its use are discussed in the Lond. "Elec. Rev.," Feb. 15, in which, however, but little more is given than was contained in our abstract. The material itself is not new, as it was produced long ago by Wohler and later by Travers, though not by this process; carbides of barium and potassium and other elements also produce acetylene. It is calculated that the cost of the electric power from central stations would be over 10 times the figure on which the previous estimate was based and that the success of this compound therefore depends entirely on cheap water power; only 5 per cent. of the heat produced by coal is recoverable in the electric furnace. Belief is expressed that there is no immediate cause for apprehension, as the original estimate of the cost was probably much too high. Prof. Lewes states that 1 hp of electrical energy consumed in incandescent lamps gave light equal to 28 compared with 44 given by 1 hp consumed in producing acetylene light through the aid of the carbide; this difference is not sufficient to make steam-generated carbide and acetylene light compete with electric incandescent ligh the cost of handling, packing, storing and selling would never be made up by this difference; at 3.25 watts per candle the two lights are equal, power for power, and with arc lamps the tables are turned completely, the figures being 80 as against 50 for the acetylene light.

Boride of Iron.—An Academy paper by Mr. Moissan is abstracted briefly in "L'Ind. Elec.," Feb. 10.

Training of Electrical Engineers.—Mr. Cahoon's article is concluded in "El. Power" for February (see Digest Feb. 2). The object of the course at the works of the General Electric Company is to give a thorough knowledge of the various processes through which a piece of electric apparatus is carried from its inception to its completion and to familiarize the student with the principles involved; he believes the tendencies of colleges is to go too much into abstruse technicalities; for one who intends to become a designing engineer such a course is excellent and necessary; he believes there shoud be a broader English and business education; few, if any, of the colleges impart a knowledge of engineering as outlined by him. He discusses the future prospects of a student and calls attention to the fact that the supply is greater than the demand and that the remuneration is therefore less in this field than in any other engineering profession, with a tendency to decrease still further; electrical engineering is becoming a settled profession and the men who compose it are compelled to work much harder and under greater tension than in any other of the engineering professions. "If a young man is willing to work in an exceedingly interesting field for a very small salary, with but little prospects of ever getting a large one, and is content to receive as his reward the honor and glory belonging to the electrical profession, then let him enter the electrical field; but if he is looking after money and will not be satisfied unless he does get it, then it would be better for him to enter some other field."

Cleveland.—The greater part of the issue of the "Elec. Eng.," Feb. 20, is devoted to a long, illustrated description of Cleveland and its electrical industries. The "West. El." and "Elec. Age.," Feb. 23, publish descriptions of some of the electrical industries of that city.

Stanley Works.—The "Elec. Eng.," Feb. 27, gives a well illustrated description of the works of this company and of some of its apparatus.

First Aid in Electric Accidents.—The "Elec. Rev.," Feb. 20, reprints the article of Dr. Hedley from the Lond. "Lancet" mentioned in the Digest Oct. 13.

Biographical.—A large number of brief biographies with portraits of "early electrical salesmen" are published in "El'ty.," Feb. 20.

New Books.

Electrical Engineering. For Electric Light Artisans and Students. By W. Slingo and A. Brooker. New and revised edition. London: Longmans, Green & Co. 753 pages, 346 illustrations. Price, $3.50.

This works treats of the various subjects pertaining to electrical engineering in a manner to be easily followed by students who have never had the advantage of a mathematical training. The exposition of theories and laws and the descriptions of instruments and machinery are, in general, clear and accurate, and well calculated to give a good understanding of the principles that underlie the construction and use of electrical apparatus. Students not familiar with the fundamental principles of electrical science will find this work to lead up by easy steps from the foundations of electrical science to the explanations of the operation of electrical generators and motors, the methods of measurement of electrical quantities, and the principles underlying the design and construction of electrical engineering works. In the description of apparatus and machinery, however, the student will find little that pertains to electrical engineering practice in the United States, and to the American student, therefore, the great value of the work will consist in its clear and simple elucidation of the principles that pertain to all electrical engineering practice. The work begins with a statement of the fundamental phenomenon of bodies electrified by friction. From these the ideas of potential, current and resistance are developed and the units in which they are measured (?) defined. At the end of the second chapter is a very clear explanation of the derivation of the C. G. S. units. The third chapter relates to primary batteries.

Chapters IV. to VII. relate to instruments and methods of measurements. Several English and Continental instruments are described, but no mention whatever is made of the Weston instruments manufactured in this country. This seems inexcusable, even in an English work revised after the World's Fair at Chicago, where, upon motion of Prof. Ayrton, the Weston instruments were adopted as the standard in the tests by the jury of award.

In the five following chapters the theory of dynamo-electric generators is quite fully discussed, and several typical forms of machines are described. The characteristics of the magnetic field are well explained, and the relation between strength of field and magnetizating force developed from the analogy of the magnetic to the electric current is well treated, and the author very properly describes as one of the simplest

forms of dynamos a machine in which there is no moving wire, but where the magnetic field is varied by the movement of a mass of soft iron.

The following chapters treat of storage batteries, arc and incandescent lamps, system of distribution, and electric meters. More space might well have been given to the subject of distribution, and it would have been well if the methods of proportioning conductors, the advantages of the three-wire system, etc., had been more fully treated. As already stated, the authors' descriptions and explanations are generally clear and accurate, and the work will prove a valuable one to the class of readers for whom it was intended. But there are some errors and misapprehensions, which are the more to be regretted since those for whom the book was written would not be likely to discover them. The authors give several pages to a proof that an electric current does not flow from one ground plate to another, and state that "anything more unreasonable than such a hypothesis (that such currents exists) it is really impossible to conceive," and then admit at the end that, in the case of electric railways using large currents, there may be such a flow, apparently entirely obvious of the fact that the difference betweeen that and a telegraph line is only one of degree.

They are not clear as to the meaning of difference of potential, and the distinction between difference of potential and electromotive force. They tell us that "Where there is no difference of potential there can be no flow of electricity," and "that electricity always flows from the body possessing the higher to that possessing the lower potential." It is a well-known fact that in every dynamo electricity flows through the armature winding and against the potential difference from the low to the high potential brush. They are careful in several references to the simple voltaic cell to say that the difference does not exist below the liquid surface, while it is well known that precisely the same effect will be produced by a contact of the plates below as above the liquid. In this connection the reviewer wishes to protest against the perpetuation of the old nomenclature based upon a mistaken theory which calls the zinc the positive and the copper the negative plate. The zinc of a cell is never under any condition in any part positive in respect to the copper.

In the discussion of magnetic leakage the authors state that in a case where the leakage was 24¼ per cent. "almost a quarter of the power spent for the purpose of developing the field in this particular case was wasted." This seems to be based on the idea that if there were no leakage so many additional lines would pass through the armature, which is very far from the truth.

In several instances the authors, in their desire to magnify the importance of a special subject, have used meaningless and exaggerated expressions that are out of place in a book of this character. Referring to Ohm's law, they say, "It is doubtful whether in the whole range of history of electrical science a law has ever been enunciated so full of truth;" one is tempted to ask for a table of laws with the percentage of truth in each. Again, speaking of the discovery of current induction by Faraday in 1831, they say, "The principles which he then discovered of the remarkable action of the varying current upon an adjacent circuit are of almost incalculable importance; while the method of constructing his original transformer, which we shall briefly describe, *was well abreast of the then existing practice.* The italics are the reviewer's.

An elementary electro-technical series is in preparation by Messrs. Houston and Kennelly, modeled somewhat after the lines of the several German and French electro-technical series which have been so well received abroad. The titles of the various volumes will be as follows: "Alternating Electric Currents," "Electric Heating," "Electromagnetism," "Electricity in Electro-Therapeutics." "Electric Arc Lighting," "Electric Incandescent Lighting," "Electrical Measurements," "Electric Street Railroads," "Electric Telephony," "Electric Telegraphy."

Improvement in Incandescent Lamps.

The following table of determinations of the efficiency of the present Packard Lamp is the result of measurements made by Mr. Jas. P. Gilbert, electrician and chemist of the New York & Ohio Company, Warren, O., and shows the rather remarkable fact that the candle power and efficiency of the lamps tested increased during 200 or 300 hours of burning. The tests were made on fifty lamps, and corroborated by several other tests; of these fifty lamps none had burned out at the end of 300 hours nor had any shown signs of deterioration at any point; at the end of three hundred hours they showed such a constant increase in efficiency that it was deemed advisable to publish the result so far obtained at once rather than wait for the complete life test. The lamp are of 16-cp and are being tested on a 98-volt direct current circuit.

AVERAGE MEASUREMENTS.

	Volts.	Current.	Total Watts.	Watts per cp.
Initial	98.2	.583 Amp.	57.25	3.59
End of 100 hours	97.4	.577 "	56.23	3.51
End of 200 hours	96.9	.571 "	55.33	3.46
End of 300 hours	96.8	.578 "	55.93	3.49

INCREASE IN CANDLE POWER AT 98 VOLTS.

Initial	16 cp
End of 100 hours	17.9 "
End of 200 hours	18.7 "
End of 300 hours	18.7 "

Ordering Railway Supplies.

BY A. W. ABELL.

Electric railway managers, like other mortals, are known to have their trials; indeed, few men are more beset than they with difficulties continually springing up, some old, others new and surprising, most of them costly. Not the least of these is the annoying delay in getting orders for supplies filled, and it is this that the writer would discuss.

The manufacturing companies are undoubtedly considerably to blame for delay in shipments, perhaps unavoidable in many cases. Are the railway companies faultless in the matter?

A most troublesome side of a supply company's business is the incompleteness of orders. Attempting to fill many of them is as puzzling as trying to direct a lost child who cries through the street, "I want mamma!"

A few examples from actual practice will illustrate. The following telegram is received: "Ship by express immediately 500 nigger heads." Anxious to accommodate his customer the manufacturer hastens about trying to learn from his associates what is meant, but none knows. How can a supply company keep posted on all local terms throughout the country? Another telegram: "Express 800 motor brushes at once." There are various makes of even street car motors, and many roads are using two or three more types of the same company's make. Hence the indefiniteness of the above order. A letter is received, calling, among other things, for "eight field coils." One naturally supposes that they are to be for railway motors until it is learned that they are wanted for circuit breakers. Whoever made out the order originally (probably the electrician or the steam engineer), no doubt had clearly in mind what he wanted, but failed to convey all his knowledge to the supply house. Another order includes "one dozen motor belts," "two dozen controller wipers," etc. There are three or four sizes of bolts on a motor, and "wiper" may be as good as the catalogue name for the part meant, but the order cannot be filled on such indefinite information.

The above instances are but samples of orders daily received, orders so destitute of specific description that it is impossible to fill them without additional information. The delay annoys the officials of the road, for they do not order until the last minute, when they are in pressing need of the material.

While manufacturers are kept constantly in hot water by these indefinite but urgent orders, their desire to please customers causes them to refrain from expressing their inner thoughts, or doing more than politely requesting that further information be sent, and the same old story continues—indefinite orders, costly delays, irritated customers. Is there no remedy for all this?

Any new business springing up so suddenly as has electric traction is apt to be imperfectly understood at first by its financial backers. "Will it pay?" is the great question, and acting on their knowledge of the old horse car business, the promoters start out to keep down expenses at every turn. It is seldom thought necessary to pay the salary necessary to keep an electrical engineer. An electrician (?) is employed, to whom everything technical is intrusted. He makes out a memorandum order which is copied verbatim on the regular order blank by the office clerk, and is then signed by the superintendent and mailed. So the indefiniteness of orders originates with the electrician, or some workman who hasn't education enough to express in specific, unmistakable terms what he has in mind. To do that is not easy even for a trained man.

As is well known, manufacturers of railway apparatus furnish illustrated catalogues, in which each part has its catalogue number, and were these catalogues intelligently *used*, vaguely defined orders would cease. These catalogues are sent to all customers. They reach the office of the railway company, but so far as can be judged by subsequent orders, there they remain under a stack of papers, often never consulted at all (as the writer well knows), or their usefulness little appreciated.

What should be done is this: The superintendent or general manager should see that those have catalogues who make out the orders originally. In the case of large railway companies, the purchasing agent, who places all orders, should send for a sufficient number of catalogues and distribute them among those who send him their memorandum orders, *i. e.*, the superintendent of the power station, line superintendents, superintendent of repair shops, etc., and should insist on the use of *catalogue numbers*. Usually he puts the order through just as it comes to him.

Were he to examine it critically and from it attempt to find in his catalogue the parts called for, he would discover how indefinite the order had been made out, and remedy the deficiencies therein before it left the office of the railway company, thus avoiding annoying correspondence, waste of valuable time, and, in many cases, days of costly delay. It is sometimes true that after careful search the catalogue number of a part desired cannot be decided upon with absolute certainty. In such cases information should be furnished as to what the part is for, where used, etc., and what is especially helpful, let a little *sketch* be made. Supply companies never dread too lengthy descriptions of parts ordered. It appears to them, however, that those who make out orders often try to be as brief and indefinite as possible. Undoubtedly these men are very busy, and make out the orders hurriedly, but they should remember that "haste makes waste" of time as well as other

things. Five minutes of concentrated thought at the start in properly making out and carefully looking over the order would often save them days of impatient waiting.

Controlling a Motor from a Distance.

BY C. F. JENKINS.

Now that electricity is coming to supersede compressed air to a greater or less extent in mining operations, many new problems will confront the practical engineer. One of the most interesting will be the handling of the small ore cars. The writer some five years ago was employed in

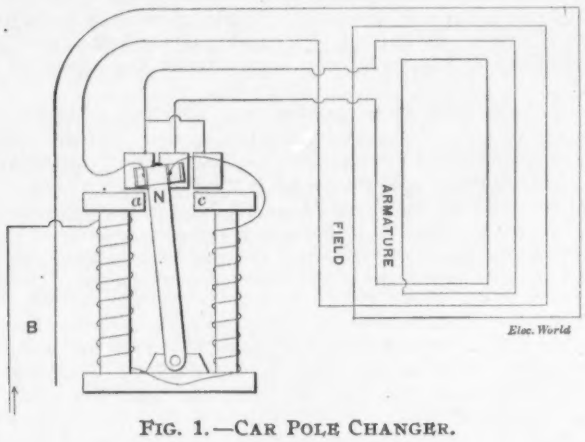


FIG. 1.—CAR POLE CHANGER.

keeping in repair engines, compressors, hoisters, etc., of a large silver mine, one hoister of which worked 2,300 feet of cable incline hoist. This shaft was well adapted for operation by means of an electric motor car, from the fact that the incline at no point was so steep that it could not be easily mounted. From the mouth of the shaft a line of track of about 800 yards led to the reduction plant. This shaft was one of those peculiar ones which follow a lead a long way and was dry throughout. As the drift was narrow and low for most of its length, the men were never permitted to ride upon the cars—in fact, it would have been almost impossible.

As there are many places where these conditions exist, a solution of the problem of the substitution of a motor for the cable car in this particular case is given herewith.

The cars, both on the shaft track and on the track leading to the mill, must travel unattended the whole distance and be under the absolute control of the engineer at the head of the shaft, to move forward and backward at will over any portion of the entire track.

This is accomplished in the following manner: Upon an ordinary motor car bed an automatic pole-changer is mounted and inserted in series with the source of supply, as in Fig. 1. Now, the operation of this piece of mechanism is such that when the current in the leads *B*, which, in the case under consideration, may, owing to the extremely dry condition prevailing, be the two rails of the track, flows in the direction of the arrow, then will *a* of the electromagnet of the pole-changer become a south pole and attract the north pole of the permanent magnet *N*, upon the upper extremity of which a block of insulating material,

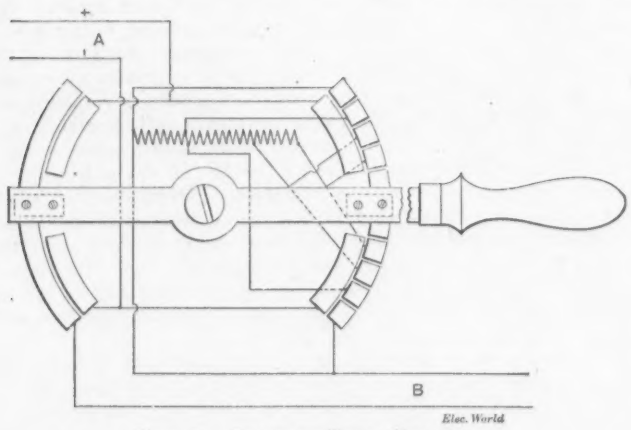


FIG. 2.—STATION POLE CHANGER.

supporting two brass contact pieces, is secured. As these pieces make contact with the terminals of the armature, a circuit is completed through the motor and the rotation of the armature is such that it moves the truck forward, let us say. Upon a reversal of the direction of the current in the leads *B*, the *a* pole of the electromagnet becomes a north pole and the *c* a south pole. Of a consequence, the vibrating tongue or permanent magnet *N* instantly responds to this new condition and swings over until its *N* pole comes against the *c* pole, which is a south. This reverses the terminals of the armature, and, necessarily, as the current in the leads has been changed, the direction of the current in the armature remains the same as before. As the current through the fields has been reversed, and that through the armature has not been changed, the rotation of the latter is reversed and the car moves backward. As this action can be produced at any time, no matter upon what part of the track the car may be, we have accomplished the desired end.

Fig. 2 illustrates a convenient form of station pole-changer for reversing the current in the leads *B*, which, in the case under consideration, are the rails, *A* being the mains or source of supply. The speed of the car is increased as the switch is thrown more from the centre. If the lever is thrown over to the left the car, according to the discus-

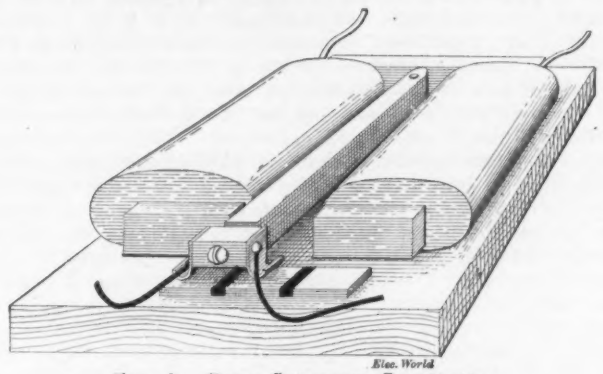


FIG. 3.—POLE CHANGER CONTACTS.

sion above, travels forward with increasing speed as the lever is moved from block to block. The reverse is likewise true, except as to direction of rotation, using the same resistance, however, as will be seen.

In order to prevent short circuiting, the automatic pole-changer contact blocks should be rather wide apart and filled in, as shown in Fig. 3, with some non-conducting material.

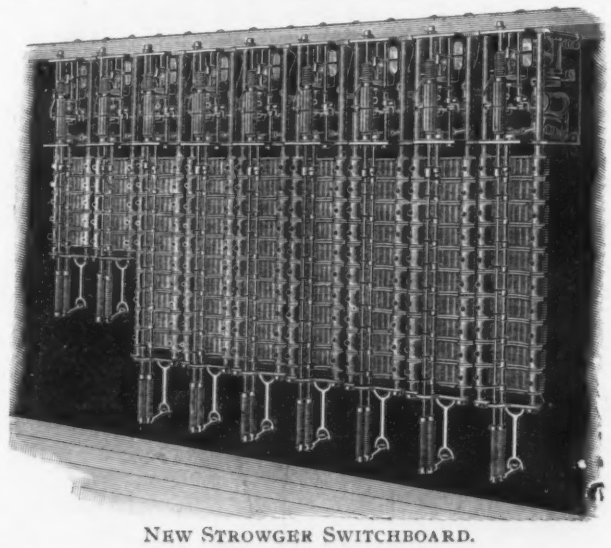
It is scarcely necessary, however, to say that where a motor is employed in hauling a train of trailers, a trolley strip or wire conductor should be used for one lead. This is not so expensive in first cost, however, as the cable, and is subject to practically no wear.

This system would seem to possess considerable merit for several reasons. It is flexible, adapting itself readily to many and varying conditions for both stationary and car motors. It is economical, needing no motorman other than the controlling station attendant, who can be so situated as to operate quite a number of motors on as many different tracks. The weight of a driver on each car is obviated, and where cars are small ones this is a feature worthy of consideration.

It is equally well adapted to series or shunt machines, and so far as tested, has developed no weak points.

New Automatic Telephone Switchboard.

The accompanying illustration represents the new switchboard of the Strowger Automatic Telephone Exchange, Chicago. As will be noticed,



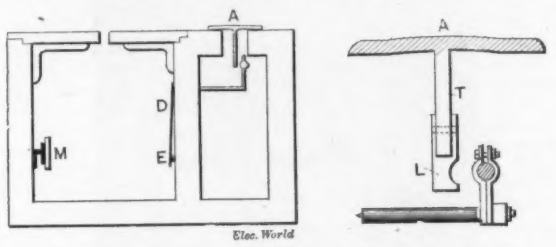
NEW STROWGER SWITCHBOARD.

the new board is mounted vertically whereas the old one was set up in a horizontal position. This simple change permits the elimination of all springs from the re-setting mechanism, the drops being reset by gravity, obviating, it is said, tendency to stick or work sluggishly, and the uncertainty which was occasionally manifested in the operation of the old style switchboard. The new board possesses the additional advantages of occupying very much less floor space than did the old one and being more convenient of access in making adjustments, etc.

Conduit Electric Railway System.

A patent has recently been granted Mr. W. L. Hedenberg for a conduit railway system, the principal features of which are that the use of the rails as a return is abolished, the circuit is not grounded, and the permanently live conductor is enclosed in a sealed conduit. While none of these principles is new, the detail method of applying them may be found interesting.

The conduit, as shown in cross section by Fig. 1, may be constructed of creosoted timber, but concrete is preferable. As shown in the drawing there are two entirely separate compartments, one having a slot and the other being hermetically sealed. The main trolley wire, with the necessary feeders, are in the sealed compartment, the former being held in place by a pair of metal clamps. These clamps are attached to a piece of hard rubber or vulcanized fibre. To the latter a small arm is bolted which passes through the wall into the adjoining compartment, and which is connected to a metal plate by means of a pivot. This



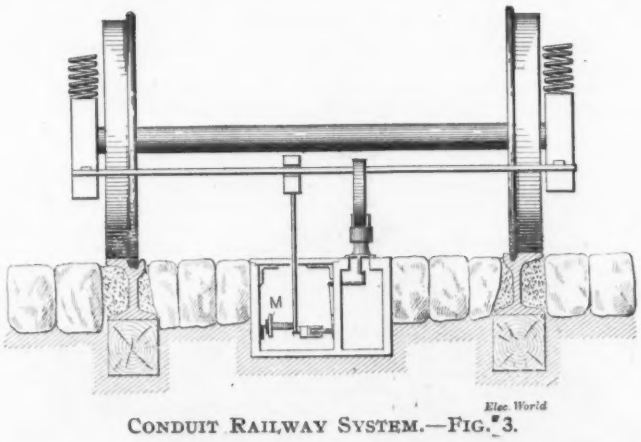
CONDUIT RAILWAY SYSTEM.—FIGS. 1 AND 2.

plate, shown at *D* in Fig. 1, is also pivoted to the partition between the compartments, and held away from the partition at the lower extremity by means of a spring, *E*. So long as this spring is not pressed down the conductor is held away from the projection on the aluminium bronze plate, *A*, in the sealed compartment.

The modus operandi is as follows: The car carries an arm to which a pair of insulated rollers are attached, running horizontally. One of these rollers presses down the plate shown in Fig. 1 at *D*. By pressing this plate it throws the conductor in the closed compartment in contact with a heavy piece of carbon, *L*, Fig. 2, the latter being firmly attached to the aluminium bronze projection, *T*, Figs. 1 and 2. The current immediately passes to the surface of the aluminium bronze plate and is taken off, by means of either a brush or wheel on the car, as shown in Fig. 3. These plates are about six feet in length and insulated one from the other, so that at no time will more than two plates be in circuit and these will be directly under the car.

The current passes from the brush through the motor, but instead of returning as usual through the rails, passes down the arm carrying the insulated wheels, and by means of a brush held in place by a spring, as shown in Fig. 3, it is transferred to an insulated plate, *M*, fastened to the side of the slot conduit. This arrangement obviates the use of the rails as a return, and eliminates the objectionable practice of grounding one side of the circuit. The conduit should be drained at the lowest points, and when no car is passing the surface plates of the unsealed compartment may be removed and any accumulation of dirt flushed out. The compartment containing the main conductor is watertight, the only openings being one every 25 inches where the quarter-inch arm passes through the dividing wall, and this is so arranged that no water can work through. The contact plate carried by the arm, *D*, to which the conductor is attached, as shown in Figs. 1 and 3, is 14 inches in length. One of these is placed every 25 inches, centre to centre, so that one plate is depressed by one of the horizontal wheels in the slot conduit before the other plate is released, thus assuring a constant flow of current, and no sparking when contact is broken.

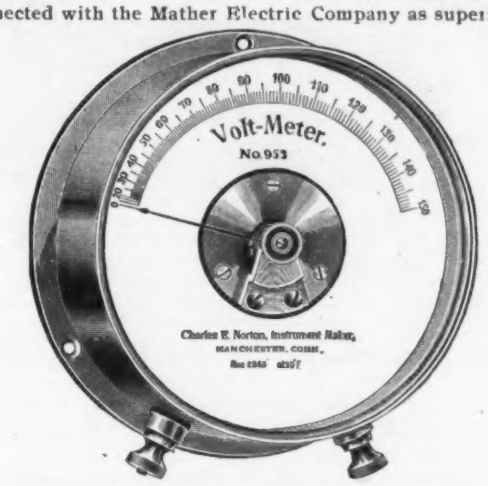
The advantages claimed are as follows: First, simplicity of construction; second, doing away with the necessity of using the rails as a return, and third, cheapness of construction, the estimated cost with concrete conduit, conductors, labor, etc., being $20,000 per mile.



CONDUIT RAILWAY SYSTEM.—FIG. 3.

Magnetic Vane Voltmeters and Ammeters.

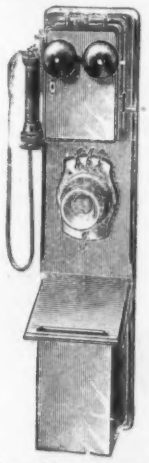
We illustrate below a magnetic vane voltmeter, manufactured by Charles E. Norton, Manchester, Conn. Mr. Norton was for a number of years connected with the Mather Electric Company as superintendent of their instrument department when that company was making the M. V. instruments sold by Queen & Company, of Philadelphia, and since the Mather re-organization he has built these instruments for them, so that magnetic vane voltmeters and ammeters have been known to the trade for the past five years. Mr. Norton has, however, greatly improved the instruments, in appearance as well as construction, and guarantees them to be accurate within two per cent.



IMPROVED MAGNETIC VANE VOLTMETER.

Combined Long and Short Distance Telephone.

We illustrate herewith the combined long and short distance telephone manufactured by the Gerson Electrical Manufacturing Company, of Philadelphia, which is claimed to be exceptionally efficient. It is said that a recent governmental test in competition with a number of other instruments demonstrated an efficiency of 99 per cent. for the Gerson instrument, while the next highest efficiency reached by any of the other makes was 90 per cent. and the average efficiency of the lot, exclusive of the Gerson instrument, was 81 per cent., 100 being taken as perfect. The instrument works equally well on long or short lines without any adjustment.



NEW TELEPHONE.

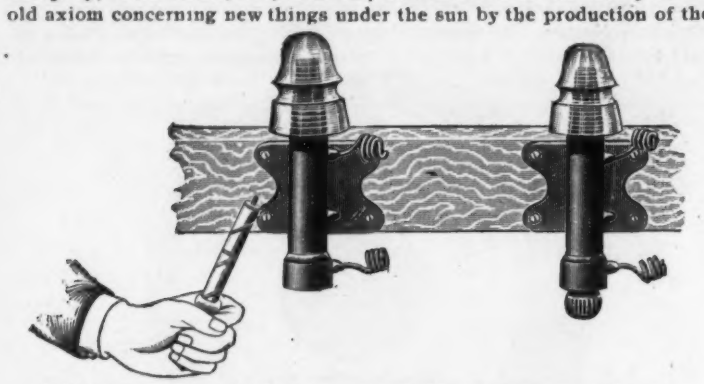
Hot Blast Blow Pipe.

The gasoline blow pipe we illustrate is manufactured by the White Manufacturing Company, 40 State street, Chicago, under the name of the Imperial hot blast blow pipe, and is claimed to give a much hotter blast than the usual forms of gasoline torches in use. It burns four hours with one charge, and has a renewable seat for the needle valve which when worn can be replaced at a small cost, the torch then being practically as good as when new. The reservoir is made of one piece of rolled brass of special quality, rendering it leak proof, and is a third lighter than usual forms. The air valve is at the bottom of the pump, conveniently placed, thus dispensing with the various outside tubes and trappings usually present, and rendering it handier and less liable to get out of order. The pump is extremely simple, supplies a strong blast and drains every drop of gasoline.

GASOLINE TORCH.

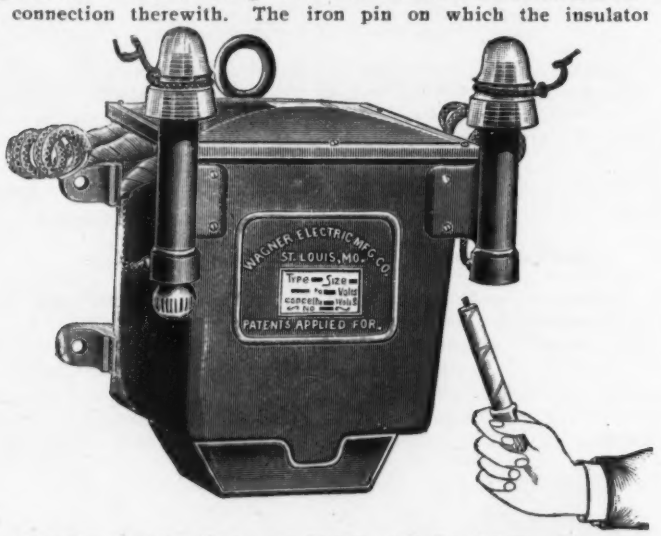
Some Novel Specialties.

The development and manufacture of electrical devices has reached such a stage that anything genuinely new and at the same time practical is seldom brought out nowadays. The Wagner Electric Manufacturing Company, of St. Louis, has, however, demonstrated the fallibility of the old axiom concerning new things under the sun by the production of the



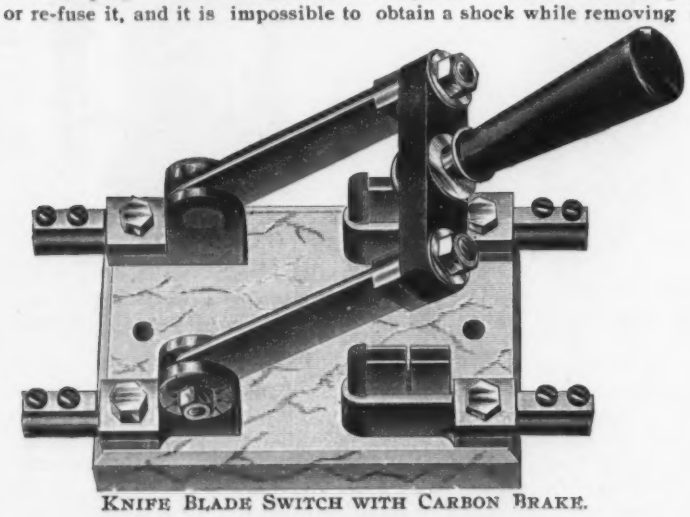
Combined Fuse Box and Insulator Bracket.—Fig. 1.

combination fuse box and insulator bracket which we illustrate herewith. The cut is almost self explanatory. Fig. 1 shows the arrangement bolted to a cross-arm or a similar support for independent use, and Fig. 2 shows the same arrangement but attached to a transformer for use in connection therewith. The iron pin on which the insulator is



Combined Fuse Box and Insulator Bracket.—Fig. 2.

screwed is hollow, and a lava plug carrying the fuse and contact pieces is screwed into this hollow pin from below. The shell of the insulator pin is lined with a lava bushing, and the device is said to break a 5,000-volt circuit carrying fifty amperes without producing an arc or damaging the lava plug. No tools whatever are required to remove the fuse plug or re-fuse it, and it is impossible to obtain a shock while removing or



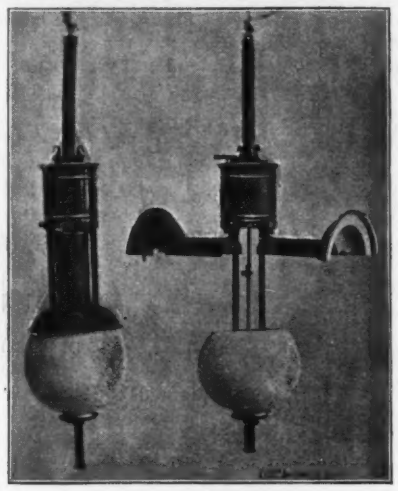
Knife Blade Switch with Carbon Brake.

replacing the plug. The use of the device as shown in Fig. 1 obviates the use of separate brackets or pins in leading the primary wires to the transformer, and saves the trouble and cost of drilling holes in walls for the attachment of such brackets, while in cases where the transformer is placed inside the building or a separate fuse box is insisted upon, the arrangement shown in Fig. 2 may be used to advantage.

Another meritorious device recently brought out by the Wagner Company is the knife switch with carbon break also illustrated herewith. The carbon break is secured by placing in front of each contact jaw a socket electrically connected with the jaw and containing a carbon pencil which is pressed outward by a spring. When the switch is opened the pencil follows the blade until the latter is clear of the jaw, thus relieving the jaw of the arc. It is claimed that it is impossible to burn or damage the contact jaws by any amount of use, and when the carbon pencils wear away they can be replaced at trifling cost.

Arc Lamp Spark Arrester.

The accompanying engraving illustrates a simple spark arrester for arc lamps which is being put on the market by the S. K. C. Specialty Com-

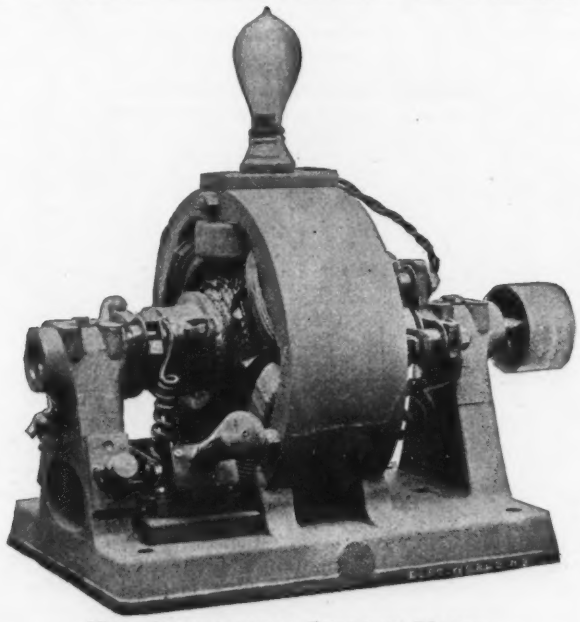


Spark Arrester.

pany, of Pittsfield, Mass., and which is claimed to possess several features of merit. The arrester is divided vertically in half, as shown, and when open is entirely out of the way of the trimmer. The globe may be removed for cleaning, etc., and fresh carbons put in without removing the spark arrester or experiencing any inconvenience from its presence. The device is substantially constructed of stout material, reinforced around the edges, and is calculated to stand a considerable amount of service.

A New Alternating Current Motor.

We illustrate below an alternating current motor manufactured by the Phillips Electric Motor Company, of 120 Liberty street, New York, which is claimed to be self-starting under load on a simple alternating circuit. It is further claimed that this motor runs at uniform speed



New Alternating Current Motor.

with an efficiency equal to that of the best direct current machines, and that it has been evolved from an extended practical experience in the construction of numerous types of alternating current machines, with the result that all the defects and drawbacks present in former motors have been eliminated in the design of this one. The new motor is now manufactured in all sizes from 1 to 10 horse-power inclusive.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, March 2, 1895.

ELECTRICAL STOCKS have had to suffer along with all the rest of the list as a result of the depression into which Wall street was plunged this week. Not being quite so active as a good many of the steam railroad and so-called industrial issues, the effect on quotations has been less serious, but the fact that they are sadly neglected would result in any attempt to market electrical stocks at the present time proving a matter attended with very disagreeable and unsatisfactory consequences. Electrical stocks should not be in the dumps; all trade advices agree in reports of activity and revival, but Wall street refuses to be encouraged by even a highly successful bond sale, and sells stocks with a perversity hard to understand. But one can now hope for better things. After to-day the "Ivy Handle" Congress is a welcome thing of the past; a big business revival is confidently counted on, and, what with the whole stock list tremendously oversold, any buying should result in a vigorous bull movement.

WESTINGHOUSE ELECTRIC issues have for the moment dropped completely out of sight, so far as any transactions in them are concerned, though very little change can be noted in quotations. Exception must be made to the scrip; that rules very strong, 96 ex-interest having been bid for it at one time during the week, though 94 ex-interest is now the ruling quotation. The scrip carries 6 per cent. with it.

AMERICAN BELL TELEPHONE stock still suffers from lassitude. The most gratifying circumstance to record in connection with this security is the record of instrument output just published, which is a very valuable straw as indicating the direction of currents in the commercial atmosphere, for the more telephones used the better business in general must be. For the month ending February the gross output increased 5,918 instruments; the net output increased 4,944. From Dec. 20 to Feb. 20 the net output was 5,350, an increase of 8 865 over a similar period in 1894, showing a much improved state of affairs in general. Some attempt was made this week to create fictitious bull enthusiasm in the stock by publishing a statement to the effect that the "Bell Telephone Company now has a surplus of between $35,000,000 and $40,000 000, mostly in stocks of its sub-companies, which is equal to from 175 to 200 per cent. on the present capital." It was very properly pointed out that the company's own report contradicts any such absurd calculations. The main item of asset in the ledger balances on Dec. 31, 1893, was "stocks $37,065,131," and, so far from these stocks being a surplus in themselves, the whole ledger balance does not foot up more than $45 712,340.

ELECTRIC STORAGE COMPANY stock of Philadelphia promises greater activity by the organization of a sub-company—the Manhattan Storage Battery Company of New York. This concern, already duly incorporated with a capital of $600 000, is to control the entire sale of the Electric Storage Company's accumulators in New York and Brooklyn, which means the practical monopoly of the business in these cities. The object in forming a New York branch is to bring the company on the selling ground and also to financier the sale of accumulators in more satisfactory manner than heretofore. One of the impediments to a wider market of storage batteries has been the first cost, and the Manhattan Company intends to alleviate this by making easier terms to the buyers. The accumulators will be sold on sort of an installment plan. In this way the first cost will be reduced and the time payments will make it possible for many to purchase batteries, who would not under old terms. The ample capital of the concern allows of this arrangement. The officers and incorporators of the Manhattan Storage Battery Company are: James H. Hoffman, president; Louis Stern, vice-president; August Belmont, treasurer; Lewis May, secretary, and Ignatz Boskowitz.

ELECTRIC TRACTION STOCKS.

	Bid.	Asked.
Union Ry. Co. (Huckleberry)	112	115
Brooklyn Traction, com	9⅛	10⅛
" " pref	52⅛	54⅛
Long Island Traction	6½	7
Rochester St. Ry	36	40
Columbus St. Ry	46	48
Louisville St. Ry. com	37	39
" " " pref	87	88
Cleveland Electric Ry.	59	60
Cleveland City Ry.	68	70
North Shore Traction	23	25
New Orleans Traction	15	16
New Orleans Traction pref	58	60
Worcester Traction com	10	11½
" " pref	77½	79
Metropolitan Traction, Philadelphia	96½	97
Philadelphia Traction	88	88⅛
People's Traction	49	50
Binghamton R. R. common	100	—

BONDS.

	Bid.	Asked
*Union Ry. 1st. mtge 6s	105	108
*Westchester Electric 1st. mtge. 5s	98	101
Rochester St. Ry. 1st. 5s	95	97
*Columbus St. Ry. 1st 5s	95	97
Columbus Crosstown 1st. 5s	95	97
*Binghamton Railroad Co. 5s	99	100

* With accrued interest.

GENERAL ELECTRIC has sadly disappointed believers in the stock's inherent strength. It has developed a tendency to sag even in those rare intervals when other stocks were disposed to brace up a little, and has betrayed a droopiness hardly encouraging to the people who for weeks have been endeavoring to bolster up the price. Company reports furnish no warrant for the continued heaviness of the stock. A semi-official statement published this week both in New York and Boston conveys the reassuring information that the General Electric Company is now earning above $2,500,000 net per annum, and, if orders continue into the present fiscal year beginning February last at the rate noted for the past two months, there will be no need to bother any further about the capital impairment question, as the company will earn itself into a sound position. The statement goes on to recite that the company is earning five times the amount of the preferred stock dividends now accumulating, and there will be no difficulty paying them when the capital question is once fully settled. The statement adds: "The General Electric Company is doing the largest business in its history as respects the volume of the output measured in tonnage or pieces of machinery, and were the prices equal to those of three years ago, it would be earning about 30 per cent. per annum on its capital instead of having its capital selling at 30 per cent of what it has cost most of its owners. Prices are low, but the cost sheets have also been liberally reduced by the introduction of new machinery and labor saving devices. The company has earned during the past fiscal year above $1,500,000, but it has continued—here is the important part of the inspired statement—to charge off with a liberal hand and will shrink its assets still further in the final accounting, so that probably very little margin of earnings above what may be necessary will be shown, and the capital account, which is now all a matter of bookkeeping, may be still further written down, *swelling the capital deficit of last year.*" This is what Wall street is afraid of, and this statement is taken as a first announcement of what the annual statement now near at hand may really have to show.

UNITED ELECTRIC SECURITIES holders have had the following profit and loss account for the six months ending Feb. 1 furnished them: Underlying bond interest and dividends received, $157,581; collateral trust bond interest and expenses $116,833; net $40,753. Profits from the sale of underlying bonds and purchases of collateral trust 5s were $63 655, making the total net for the six months $104,408. The surplus on Aug. 1, 1894, was $180,556. Since then there has been charged off $97,220 and $35,000 for preferred dividends, leaving a surplus on Feb 1, 1895, of $48,336. The $500,000 common stock, $1,000,000 preferred stock and $4,188,000 collateral trust 5 per cent. bonds now have behind them $5,736,336. The collateral 5s were redeemed at about 1¼ per cent. over subscription price. The price of the underlying first mortgage bonds sold—there are $5,846,000 of these deposited to secure the collateral trust 5 p r cent. bonds—averages 89. If the remaining bonds were sold at 73 2, the proceeds would retire the collateral 5s at 103.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Chicago Edison Company	100	128	130
Edison Electric Ill., New York	100	96	99
" " " Brooklyn	100	107	110
" " " Boston	100	124	125
" " " Philadelphia	100	120	124
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	31	32
General Electric	100	28	29
General Electric, pref	100	61	65
Westinghouse Consolidated, com	50	30½	31
" " pref	50	50	51

BONDS.

Edison Electric Ill., New York	1,000	105	106
Edison Electric Light of Europe	190	75	85
General Electric Co. deb. 5s	1 000	89	90

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	192	193
American District Telegraph	100	40	45
American Telegraph & Cable	100	90	92
Central & South American Telegraph	100	117	120
Commercial Cables	100	130	140
Erie Telephone	100	49	50
Gold & Stock Telegraph	100	105	110
Mexican Telegraph	100	180	190
Mexican Telephone	100	70	80
New England Telephone	100	67	69
New York & New Jersey Telephone	100	102	105
Postal Telegraph-Cable	100	55	58
Western Union Telegraph	100	87½	88

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 BROADWAY, NEW YORK, March 4, 1895.

MR. W. B. ALLEN, chief sales agent of the Brownell Car Company, St. Louis, is likely to earn a reputation with his customers for ubiquity, so indefatigably and frequently does he get around among them.

MR. ERNEST S.W. MOORE, electrical engineer of the Elwell-Parker Electrical Company, of America, and formerly connected with the parent company in England, has been in New York during the week.

MR. EDWARD S. ALLEN, representing the Swan Lamp Manufacturing Company, of Cleveland Ohio, in the States of New York, Vermont, New Hampshire and Maine, is making the Swan lamp better known, if possible, than ever before. His untiring efforts are bringing satisfactory results for both his company and its customers.

THE ANGLO-AMERICAN ELECTRIC MANUFACTURING COMPANY has removed from 80 Pine street to 25 Whitehall street, New York.

THE GERST TELEPHONE BILL, now before the legislature, provides that a corporation may, after an investigation by a State commission, charge its subscribers a rate sufficient to allow the telephone company 10 per cent. profit on its invested capital and bonded indebtedness. The Metropolitan Telegraph & Telephone Company is fighting the bill most bitterly, while the New York Board of Trade and Transportation is as vigorously pushing it, on the ground that the Metropolitan Company has "fattened upon the people" under a $150 rate, and yet insists upon an increase of rental to $240.

THE FIRST ANNUAL BALL of the employes of Zimdars & Hunt, electrical contractors, took place at Lyric Hall on the evening of Washington's birthday. The hall was handsomely decorated. The chief feature was the electrical display, which consisted of an entire electric illumination of the stage end of the hall, and included some very novel and surprising effects. Two columns supported an arch, upon which was mounted about seventy-five incandescent lamps The shaft of each column was entwined with smilax, interspersed with roses, and round each column there was also disposed about fifty incandescent lights. On the caps of the columns were two American shields with flags draped each side, the colors in shields being illuminated by numerous small electric lamps. Above the arch were numerous novel devices displayed, one reading "employes of Zimdars & Hunt," also the familar formula C E, all being illuminated by electric lights, making a pleasing and handsome effect. The decorations were designed by Mr. J. P. Smith and executed by the employes of Zimdars & Hunt under the superintendence of Mr. J. F. Vielberth, assisted by Messrs. Geo. Ruckle, J. I. C. King and Geo. McGibney, foremen. Mr. Geo. T. Butler presided. There were doubts among the many friends of the employes of Zimdars & Hunt as to whether the strike in the electrical trade would not seriously interfere with the success of the undertaking. Notwithstanding this, owing to the able management, to whom great credit is due, it far exceeded the expectations of the most sanguine. At 9 o'clock Prof. Douthwaite, with full orchestra, discoursed sweet music for the promenade concert, which lasted till 10 o'clock, after which the grand march took place, followed by dancing, which was continued till the small hours of the morning. At the supper table cheer after cheer was given for the firm of Zimdars & Hunt, the firm being represented by Mr. Hunt, who was also accompanied by his wife and family. After their healths were proposed quiet would not prevail till Mr. Hunt, who is always equal to the occasion, addressed the assemblage, and in a short speech congratulated the employes and gave them much praise for achieving such success in their first annual ball, stating that a jollier lot of strikers he had never met.

General News.

New Incorporations.

THE MAGNOLIA AVENUE RAILWAY COMPANY, Jefferson City, Mo., capital stock $50,000, has been incorporated by Thos. J. Prosser, W. W Penny and others.

THE FREEPORT ELECTRIC LIGHT & FUEL COMPANY, Freeport, Ill., has been incorporated by Chas. D. Knowlton, Louis Stoskopf and others. The capital stock is $100,000.

THE SOUTHWESTERN ILLINOIS TELEPHONE COMPANY, East St. Louis, Ill., capital stock $100,000, has been incorporated by Anthony Isch, Daniel Sullivan and A. Rodenburg.

THE CAMBRIDGE CITY ELECTRIC LIGHT COMPANY, Cambridge, Ind., capital stock $20,000, has been incorporated by Edward W. Boden, Chas. H. Kerlin, and Thos. B. Stephens.

THE NANTASKET ELECTRIC STREET RAILWAY COMPANY, Hull, Mass., capital stock $12,500, has been incorporated. The parties interested are B. T. Harrington, G. F. McKay and J. L. Mitchell.

THE TROY TELEPHONE COMPANY, Troy, O., capital stock $10,000, has been incorporated by J. M. Campbell, J. O. Dabis, K. Harter and others for the purpose of operating a telephone exchange in Troy.

THE MONTGOMERY ELECTRIC COMPANY, Ambler, Pa., capital stock $1,000, has been incorporated to supply light, heat and power. Henry Parker, H. A. Murphy and R. L Parkinson, Philadelphia, Pa., are interested.

THE ST. LOUIS BELT RAILWAY COMPANY, St. Louis, Mo., capital stock $2,000,000, has been incorporated to construct a belt line in that city to tap all the street railways and giving every line and system connection with others.

THE VERMILLION WATER, LIGHT AND POWER COMPANY, Vermillion, So. Dak., capital stock $25,000, has been formed to furnish water and light to that city. G. T. Salmer, S. E. Brookman and E Brookman, all of Vermillion, are interested.

THE HARRISON ELECTRIC COMPANY, Chicago, Ill., capital stock $500,000, has been formed to manufacture all kinds of electrical machinery, appliances and devices. The promoters are Edward M. Harrison, Lewis H. Painter and Lewis Rinaker.

THE MURPHYSBORO GAS LIGHT COMPANY, Murphysboro, Ills., capital stock $30,000, has been formed to manufacture gas and to maintain and operate water works and electric light plants. J. D. Peters, P M. Post, W.C. Norman and E. Kirchner are interested.

THE JAEGER ELECTRIC LAMP COMPANY, Newark, N. J., capital stock $10,000, has been formed to manufacture and sell electric lamps, etc. Herman G. Jaeger, Norman D. Webster, Brooklyn, N. Y., and Louis J. Auerbacher, Newark, N. J., are interested.

THE VIRGINIA TELEPHONE COMPANY, Norfolk, Va., has been incorporated, with D. Lowenberg, president; R. W. Arnold, vice-president, and Charles Pickett, secretary and treasurer, to operate lines in Virginia. The capital stock is $5,000 with the privilege of increasing it to $100,000.

THE COSMOPOLITAN ELECTRIC COMPANY, Chicago, Ill., capital stock $2,000,000, has been incorporated to generate and supply electricity and manufacture and sell appliances for light, heat and power; construct plants, etc. Albert H. Tyrrell, Wm. H. Pope, and Walter H. Marble.

THE MANHATTAN ELECTRIC STORAGE BATTERY COMPANY, New York, capital stock $600,000, has been formed to manufacture electric storage batteries and any apliances connected therewith. August Belmont, J. H. Hoffman, Louis Stern and Lewis May, of New York, are interested.

THE COMMERCIAL HEAT AND POWER COMPANY, Chicago, Ill., capital stock $2,000,000, has been formed to construct, maintain and operate a plant for furnishing heat and power, to construct and maintain pipes, mains, etc. The promoters are Daniel V. Harkin, Harry C. Colson and M. W. Cagney.

THE FRANKLIN ELECTRIC ILLUMINATING COMPANY, Oyster Bay, N.Y., capital stock $25,000, has been formed to generate and use electricity for heat, light and power in Sea Cliff, Glen Cove, etc., L. I., N.Y. The promoters are Samuel Stenson, John Graham, and W. A. Porter, Sea Cliff L. I., N. Y.

THE FULLER ELECTRIC ENGINEERING COMPANY, East St. Louis, Ill., capital stock $30,000, has been formed to manufacture and deal in electrical appliances of all kinds, build and operate electric plants and carry on a general electrical business. W. A. Fuller, Chas. T. Dana and C. H. Dudley are the interested parties.

THE THIRD STREET & SUBURBAN RAILWAY COMPANY, Seattle, Wash., capital stock $100,000, has been incorporated to build, own and operate a street railway, electric light and power plant, saw mills, etc. Angus Mackintosh, A. B. Brocker, Fred. Baueman, W. C. Crambs, Thos. Boyd, David T. Denny and Thos. Denny are interested.

THE UNITED STATES & HAYTI CABLE COMPANY, New York, maximum capital stock $500,000, has been formed to construct and maintain a line of electric telegraphs, cable (submarine, etc.,) between the United States and the West Indies, etc. John W. Mackay, Virginia City, Nev.; George C. Ward, Brooklyn, N. Y., and J. W. Mackay, Jr., New York, are the organizers.

THE NORTHWESTERN TELEPHONE AND CONSTRUCTION COMPANY, Osage, Ia., capital stock $50 000, has been incorporated. H. J. Fitzgerald president; C. H. McNieder, vice-president and H. C. Baldwin, treasurer. This company proposes to construct and operate telephone systems in Osage, Charles City, Mason City and New Hampton and to connect these towns by their lines.

THE GENERAL ELECTRIC RAILWAY COMPANY, Chicago, Ill., capital stock $5,000,000, has been incorporated to manufacture, acquire, own and use and sell, etc., etc., inventions, improvements, patents on railway appliances and devices and model patterns and samples for same, and to acquire and operate street railways. Daniel M. Simmons, Wm. A. Youmans and Geo. Pfleger are interested.

Telegraph and Telephone.

LEBANON, KY.—A new telephone exchange is to be established.

AUGUSTA, GA.—Hardy Jackson is forming a telephone company.

TROY, ALA.—A. J. Robinson will establish a telephone exchange.

BRISTOL, TENN.—A. D. Reynolds and others are organizing a telephone company.

SPARTANSBURG, S. C.—A company is being formed to establish a telephone system.

PENSACOLA, FLA.—A meeting has been held to organize a new telephone company.

SPRINGFIELD, O.—Talbott & Van Horn have been granted a franchise for a new telephone system.

CARTERSVILLE, GA.—J W Dodds and G. G. Leake, of Cedartown, are organizing a new telephone company.

BIRMINGHAM, ALA.—E. B. Bowles and others have petitioned the City Council for a telephone franchise.

OCONTO, WIS.—W. L. Porter, of Ontonagon, has asked for a francise for 10 years to operate a telephone system.

BOGUE CHITTO, MISS.—C. H. Trotter will construct telephone lines, and wishes prices on telephone equipment.

PRINCETON, ILL.—A telephone company with 100 members has been organized and an independent system wil be put in at once.

NEW ORLEANS, LA.—S. P. Walmsley, Chas. H. Schenck and others have applied for a franchise to construct a telephone system.

WEBSTER, N. C.—Jos. J. Hooker will establish a private telephone line. He desires prices of telephone equipments, including wire.

ELMIRA, N. Y.—The Northern Allegheny Telephone Company is preparing to extend its line. Long distance telephones are soon to be attached.

WESTMINSTER, MD.—R. B. Hazlett and others are forming a company to establish a telephone system to connect with a number of surrounding towns.

OSHKOSH, WIS.—Oshkosh City Council has granted Mr. Humes a telephone franchise. He will expend $30,000 on the plant and begin the work of construction at once.

PETERSBURG, VA.—The Petersburg Telephone Company, recently incorporated, is in the market for telephone poles, lines, insulators, pins, brackets, cross arms, switchboards, etc., etc.

NASHVILLE, TENN.—The Cumberland Telephone and Telegraph Company has perfected arrangements by which Nashville will have telephone connection with Chicago, and also with Eastern cities.

DENVER, COL.—The Rocky Mountain & Colorado Telephone companies

will establish a telephone line between Cheyenne and Denver. Construction work will commence as soon as the weather permits.

FARGO, N. D.—Hillsboro, Grand Forks and Fargo are to be connected by telephone. Supt. Wainman, of the Northwestern Telephone Exchange, has announced the intention of that company to build such a line in the spring.

ALTON, ILL.—The Alton Telephone Company has presented an ordinance to the City Council, asking for a franchise to do business in this city. This is an inauguration of a fight against the Bell Telephone people to bring about a reduced rate of rentals.

ELECTRIC LIGHT AND POWER.

PENN YAN, N. Y.—A municipal plant is being discussed.

SABINA, O.—Steps are being taken to establish electric light plant.

WONEWOC, WIS.—Wonewoc is agitating the question of electric lights.

RANDOLPH, WIS.—There is talk of supplying Randolph with electric lights.

TORONTO, CAN.—Municipal lighting is assuming something of a tangible shape.

CHICAGO, ILL.—A dynamo will be put in the new jail to be erected by the city of Chicago.

WINCHESTER, IND.—Fire destroyed the electric light plant. Loss $10,000; insurance $3,500.

MAUSTON, WIS.—Plans and specifications are being perfected for an electric light plant at Mauston.

SISTERSVILLE, W. VA.—W. C. Titus, of Ovid, Mich., is contemplating the establishment of an electric light plant.

CLEVELAND, TENN.—E. T. Hall will give information concerning the establishment of an electric light plant.

POPLAR BLUFFS, Mo.—The Fort Wayne Electric Light Company has been awarded the contract for lighting the city.

ALBANY, N. Y.—The Senate has appropriated $16,000 for electric lighting and other improvements in the Albany armory.

WARRENSBURGH, N. Y.—The Warrensburgh electric light works will extend its lines to Lake George in the early spring.

CHICAGO, ILL.—A dynamo will be put in to light the new factory of the Chicago Sash, Door and Blind Manufacturing Co.

REDCLIFF, COL.—The electric motor and machinery at the Tip Top mine in Eagle River canyon was badly wrecked recently.

PALMYRA, N.Y.—H. M. Howard has secured a franchise for electric lighting and will organize a stock company to erect the plant.

AITKIN, MINN.—At the March election a proposition to issue $10,000 worth of bonds for an electric light plant will be laid before the voters.

ALTOONA, PA.—The question of making a loan of $70,000 for an electric light plant will be submitted to a vote of the people of Altoona.

GRAND RAPIDS, MICH.—The mayor has vetoed the action of the council authorizing a bond issue to build a municipal electric light plant.

PASADENA, CAL.—President J. S. Torrence, of the Pasadena Electric Light Company, says his company will make a large addition to the plant.

PATERSON, N. J.—The new Boston store of the Meyer Brothers will be equipped with all modern improvements, including electric elevators.

FLORENCE, S. C.—The Florence Improvement and Manufacturing Company is in the market for an arc dynamo of 30 to 50 lights capacity, and a 1,000 or 1,500 light alternator, new or second hand.

SALAMANCA, N. Y.—It is reported that the local electric light plant has been confiscated by the Western Electric Company as a result of some difficulties beween that company and the former owner.

WILLETS POINT, L. I., N. Y.—Col. W. R. King, commandant of the United States Engineers Corps, contemplates the construction of an electrict light system at Willets Point, to cost about $300 or $400.

EAST ORANGE, N. J.—A committee composed of Dr. Waite and Israel L. Dodd and Wm. Caldwell has been appointed by the First Ward Republican Club, East Orange, for the converting of the old disposal works in East Orange into an electric light plant as soon as the outlet sewer is finished.

CUTHBERT, GA.—The city has decided to defer putting in an electric plant pending a showing from some electric light companies, who desire to put in a plant on the franchise plan. If the city can make it to its advantage to do this, it will adopt this plan, otherwise, later on, it will put in its own plant and operate and control it.

THE ELECTRIC RAILWAY.

SANDY SPRING, MD., is to have an electric railway.

FAIRVIEW, MASS.—An electric railway will probably be established.

CARTHAGE, MO.—The Jasper County Electric Railway Company is to build a power house.

UTICA, N. Y.—Beckwith & Quackenbush are now in possession of the Frankfort and Herkimer electric road.

CHICAGO, ILL.—The South Chicago City Railway Company has been authorized to construct an electric railway.

NORTH TONAWANDA, N. Y.—An electric street railway is to be constructed and an application for a franchise is pending.

SKOWHEGAN, ME.—Business men of Skowhegan are subscribing liberally for stock in the proposed Madison & Athens electric railroad.

SHEBOYGAN, WIS.—The Sheboygan City Railway Company has asked for a permit to put in a trolley system. John M. Seaman is president.

WEST SPRINGFIELD, MASS.—The Street Railway Company has asked permission of the Selectmen to extend its tracks to the Holyoke line.

HORNELLSVILLE, N. Y.—A project is on foot to build another electric railway from Hornellsville to Canisteo and other towns early in the spring.

PITTSBURGH, PA.—John B. Eichler and others are contemplating the construction of an electric street railway to run from Troy Hill to Reserve township.

LONG ISLAND CITY, N. Y.—The Long Island City & Newtown Railway Company and the Steinway Railway Company are desirous of extending their lines.

HAMBURG, N.Y.—A trolley line to connect Hamburg with Buffalo is expected shortly. Hon. Thos. L. Bunting, J. Peifer, Geo. M. Pierce and H. S. Spencer are interested.

LOWELL, MASS.—It is stated that work on a power house in this city, to supply the Lowell, Lawrence and Haverhill road, will be commenced in the near future.

ORLANDO, FLA.—An ordinance is now before the City Council to be reported upon at the next meeting asking for a franchise to operate a street railway and electric light plant.

SYRACUSE, N. Y.—Both the Syracuse Street Railway Company and the East Side Railway Company have petitioned the Common Council for franchises for extension of their lines.

NEW BRITAIN, CONN.—The Central Railway & Electric Company of New Britain has asked permission to extend its lines from New Britain through Newington to the city of Hartford.

SALAMANCA, N. Y.—A company has been formed and a charter obtained for the purpose of constructing an electric road between Little Valley and this place and extending on to Great Valley.

OCEAN CITY, MD.—The Sinepuxent Beach Company is considering the scheme of building an electric line along the beach, about six miles long. Chas. Goldsborough, of Baltimore, is president.

AUGUSTA, ME.—Petition has been made by V. R. Tuttle and 62 others for an act to authorize the Waldo and Somerset Railway Company to extend and build their road from Burnham to Sandy Bay.

FALL RIVER, MASS.—At a regular meeting of Board of Aldermen, the petition of the Fall River Railway Company asking for rights on certain streets of the city for the operation of their line was granted.

MERIDIAN, MISS.—J. T. Donovan, P. A. Bradley and others have been granted a franchise by the city council to construct an electric railway, and a new company has been formed with a capital stock of $250,000.

NEW YORK, N. Y.—The People's Traction Company, recently incorporated, will apply for a franchise in Westchester county to operate a trolley road through the Hudson River towns from New York to Peekskill.

OCALA, FLA.—Work is to begin at once on the Ocala & Silver Springs Railway, according to the statement of Secretary Anderson of the company. It will be operated first with steam dummies and later with electric motors.

ATLANTA, GA.—The Atlanta Electric Railway Company, which was incorporated to build a line in the suburbs of the city, has elected Dayton Hale, president, and D. H. Livermore, secretary. Surveys are now being made.

QUEBEC, CAN.—Mr. Beemer will begin the construction as soon as the weather will permit, of an electric railway in and around the city of Quebec. He will also construct a line to the famous line of La Bonne Ste. Anne.

HANOVER, MASS.—Franchises have been granted to the Hanover Street Railway Company to extend its lines from the corner of Webster street to Norwell, and through High and Washington streets in Norwell to the Higham line.

SYRACUSE, N. Y.—The Business Men's Association committee, which has the proposed extension of the electric railway in charge, reports that the prospects for the speedy extension of the road through West Genesee street are good.

SAN FRANCISCO, CAL.—M. J. Shiels has applied for a franchise to build a double track railway on certain streets terminating near the proposed Union depot, the line to be operated by cable, storage batteries, or smokeless petroleum engines.

NANTICOKE, PA.—The People's Railway Company, of Nanticoke, is perfecting arrangements to begin the construction of a road to pass through Alden, Wanamie, etc. Work to commence as soon as possible. The main power plant will be located near Alden.

HULL, ONT.—Peter Ryan, of Toronto, states he has secured from Mr. Viau, of Hull, the franchises for the proposed electric railway from Hull to Aylmer, and for the electric lighting of the city of Hull. Work on the electric road to commence early next summer.

DETROIT, MICH.—Right of way has been secured for an electric railway from Detroit to Mt. Clemens, Mich., a distance of 20 miles, and work will be commenced in the spring. Chas. J. Reilly, 19 Buhl Block, and C. M. Swift, 3 Bank Chambers, may be addressed for information.

MADISON, ME.—At a recent meeting held at said place a unanimous vote was given to grant the right of way to the Electric Railway Company running from Skowhegan to Madison, passing through the centre of town. Work will be commenced in the spring and completed in the fall.

BUFFALO, N. Y.—If a satisfactory arrangement can be concluded between the directors of the Buffalo & Williamsville electric road and the property owners between that suburb and Clarence, the latter place will shortly have a direct trolley connection with this city by an extension of the Williamsville line. It is to cost about $75,000.

MARINETTE, WIS.—It is probable that two additional miles of street railway will be constructed in this city in a short time. The capital stock of the gas, electric light and railway company is $100,000, which may be raised to $200,000, which figure is said to repesent the actual investments of the company. The new line will run along the bay shore.

GREEN BAY, WIS.—The Green Bay Electric Street Railway Company is canvassing for electric light subscribers with a view to putting in a plant. This has aroused the Green Bay & Fort Howard Electric Light & Gas Company, which is already in the field, and there is promise of a rate war which will make gas and electric lighting much cheaper than at present.

EAST STROUDSBURG, PA.—It is said a charter will be applied for for a road to connect at Stroudsburg with the Bangor, Pen Argyl & Wind Gap Electric Railway Company's line and run over to Lake Poponoming. Henry Fulme, of Easton, is one of the principal projectors and says that the road will be in running order by the time the summer tourists begin to move toward the mountains.

BATAVIA, N. Y.—Business men of this place are considering the matter of taking stock in the proposed railway from Batavia to Oak Orchard, by way of Albion. Gen. Avery of New York is president of the new company. Mr. Beckwith, of Albion, says that Albion people are very much interested in the project, having subscribed nearly $30,000 worth of stock. The company asks that the people west of Albion subscribe $50,000

BOSTON, MASS.—The Western New Hampshire Street Railway Company has applied for incorporation to build an electric railway from Williamsburg to Goshen, five miles; to Cummington, seven miles further, and to Worthington, eight miles more. The capital stock is to be $200,000, and Lyman D. James, Williamsburg; Alvah Barrus, Goshen; J. C. Hammond, Northampton; John Olmstead, of Springfield, Mass., and others are interested.

JOLIET, ILL.—The Joliet Street Railway Company is petitioning the Council for permission to extend its street car lines. J. A. Henry, president, states that considerable improvements, repairs and alterations should be made at once both in the plant, the track and the rolling stock of its railway; that such improvements, etc., will require the expenditure of a large sum of money, which can only be raised by the sale of bonds of said road.

FLUSHING, L. I., N. Y.—The plant of the Flushing & College Point Electric Railway will be sold. A new company has been formed consisting of Daniel Odell, E. Bayard Halstead, Paul D. Cravath, S. Kellogg and others of New York. The capital stock of the new organization is $125,000. It is inferred that the new company will purchase the plant. The new company expects to spend at least $25,000 in enlarging and improving the plant.

GOSHEN, MASS.—Promoters of the reorganized Northampton Street Railway have asked the Legislature for a charter to build a line through Williamsburg, Goshen, Chesterfield, Worthington and Cummington. The name will be the Western Hampshire Street Railway Company, and permission is asked to issue $150,000 in stock and $50,000 in bonds. The incorporators named are: Lyman D. James, of Williamsburg; Alvan Barrus, of Goshen, and J. C. Hammond, of Northampton.

MISCELLANEOUS NOTES.

MUNICIPAL LIGHTING IN DECATUR, ILL., is claimed by the *Daily Review* of that city to be a snare and delusion. The paper states that while the system of bookkeeping in the clerk's office shows an annual expense account of $5,458 for 103 lights, the actual cost of these lights is about $12,458. The discrepancy is explained by the fact that nothing is charged to interest and depreciation accounts, and all the money paid attendants is charged up to the water works, which is operated in connection with the light plant, notwithstanding several of these attendants would not be required but for the electric light plant. The lights in Decatur are run on the moonlight schedule.

ROYAL E. HOUSE, the inventor of the House printing telegraph system and many other meritorious devices, died at Bridgeport, Conn., on Feb. 25, aged 81 years. Mr House constructed in 1840 a waterwheel embodying all the salient principles of the modern turbine, and in 1844, prior to the construction of the first telegraph line of Prof. Morse (but subsequent to the issue of the earlier Morse patents) a House printing telegraph machine was exhibited in New York. This machine printed the messages in Roman characters at the rate of about 40 to 50 words a minute. The great expense of installing and maintaining the instruments, however, was prohibitive.

Trade and Industrial Notes.

THE CLEVELAND MACHINE SCREW COMPANY, Cleveland, Ohio, is sending out a very handsome calendar.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York has issued a very tasteful illustrated pamphlet, describing the Manhattan arc lamp.

THE F. E. BELDEN MICA MINING COMPANY, of Boston, has established a branch house at 182 Franklin street, New York, in charge of Mr. Union Adams, Jr., where all of its widely known products may be obtained.

THE ELECTRICAL ENGINEERING COMPANY, of Minneapolis, Minn., has published its third catalogue of electrical supplies and apparatus. The new catalogue is exceedingly comprehensive and well arranged as to contents.

THE CUTLER-HAMMER MANUFACTURING COMPANY were burned out at 8 o'clock on the morning of February 27 and before night of the same day they were ready for business at 16 South Canal street. This is lively moving around.

THE METROPOLITAN ELECTRIC COMPANY, of Chicago, is introducing to the trade a new carbon battery of high efficiency test for open circuit work. The battery is guaranteed and offered to the trade seeking a high-class article of this description.

THE ELSON & BREWSTER ENGINEERING COMPANY, New York, reports business as being very good. Orders have recently been received for electrical moulding for the Stokes building on Pine street and the Ward's Island insane asylum, and other orders are flowing in continuously. Brisk sales on woven-wire brushes are reported.

THE CHICAGO CROSS ARM COMPANY is now in its new and more spacious office at 1440-1441 Monadnock Block, Chicago, where it reports a very brisk and promising business. Having several large orders for future delivery, it was necessary also to increase the company's mill capacity to meet the increasing demand for its well-known Yellow Pine Cross Arms.

THE STROWGER AUTOMATIC TELEPHONE SYSTEM is reported as being in successful operation in La Porte, Ind.; La Grange, Ill.; Ypsilanti, Mich.; Perry, N. Y.; Albert Lea, Minn., and Chariton, Ia. Applications have been made and franchises granted for the automatic system in Philadelphia, Pa.; Brooklyn, N. Y.; Bloomington, Ill.; Rockford, Ill.; Michigan City, Ind.; Frankfort, Ind., Canton, O.; Akron, O.; Tacoma, Wash.; Bakersfield, Cal.; Sterling, Ill; Hannibal, Mo., and other places.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, have purchased of H. P. Lucas, receiver, the catalogue, good will and a large part of the stock of the Knapp Electrical Works (insolvent) and is consequently prepared to fill all orders for "Knapp" specialties promptly from Chicago stock. The Knapp catalogue is one of the largest, most complete and expensive electrical supply catalogues ever published. The Electric Appliance Company is making some revisions and additions to the original volume, making it even more complete and desirable than before.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., reports a continuation of the unprecedented amount of new business secured. The following sales have recently been made through its isolated lighting department: The Berlin Iron Bridge Company, East Berlin, Conn., second order, 250-light ring type dynamo; Perkins Electric Switch Mfg. Company, Hartford, Conn., 350-light ring type dynamo; Haverhill Paper Company, Bradford, Mass., 150-light ring type dynamo; Inter-Mountain Electric Company, Pocatello, Idaho, 450-light ring type dynamo; Hub Gore Makers, Brockton, Mass., 450-light ring type dynamo; Coffee Exchange, New York City, 600-light ring type dynamo; Iroquois Furnace Company, 150-light ring type dynamo; Cranston Worsted Mills, Bristol, R. I., 250-light ring type dynamo; New Opera House, Holyoke, Mass., 250-light ring type dynamo; Hub Gore Makers, Camden, N. J., 150-light ring type dynamo; Waverly Woolen Company, Pittsfield, Maine, 350-light ring type dynamo, second order; Thatcher Bros., New Bedford, Mass., 100-light ring type dynamo; James F. Grant, Youngstown, Ohio, 450-light ring type dynamo; Rockwell Mfg. Company, Milwaukee, Wis., 100-light ring type dynamo, second order; Burtis Howard, Minneapolis, Minn., 100-light ring type dynamo, third order; S. N. Blake, Elmira, N. Y., two 250-light ring type dynamos; B. Lowenstein & Bros., Memphis, Tenn., 100-light ring type dynamo; Straight Line Engine Company, Straight Line, New York, 20-kw Manchester type generator; Cook Locomotive Works, Paterson, N. J., 45-kw, 220-volt, multipolar generator; J. Holt Gates, Chicago, Ill., two 60-kw 500 volt, multipolar generators; Denison (Tex.) Light and Power Company, 45-kw multipolar generator, 220 volts.

THE ELECTRICAL MAINTENANCE COMPANY, 50 Broadway, New York, a corporation backed by some of New York's best financial and business men, reports that its start in the electric field has been most encouraging. The objects of this company are to inspect and maintain electric plants at a fixed rate per annum. The question of guaranteeing an installation by manufacturers, which is invariably asked for, has been a most objectionable feature in the selling of electrical plants, owing to the fact that while a plant may have been installed perfectly, some mistake by incompetent people handling the plant often develops very unpleasant questions of responsibility which the manufacturer refuses to meet. This undesirable feature is disposed of by this company's contract, which may be figured with an installation, in which case it assumes all responsibility for the period covered. The company's examiners visit plants under its care at regular intervals, and thereby not only acquaint themselves with all details, and educate the persons in charge, but are liable under the contract for any and all damage resulting from any instruction given. The company also claims that its facilities are such that in the event of a plant needing repairs they can be accomplished in the least possible time, and it is obvious that its own interests demand extraordinary exertions under such conditions. Another important advantage this company claims for its customers is that in the event of sudden absence, by reason of sickness or from other causes, of an engineer, one of the examiners, who would be thoroughly acquainted in detail with any and all plants under their charge, could be obtained in an hour or so, thus exempting the plant from damage due to the natural errors of a man unacquainted therewith. The company is becoming well established in New York, Brooklyn and vicinity, and is preparing to establish branches in all of the largest cities in this country. The officers and board of directors are: J. J. McKenna, general manager; R. L. Johnson, secretary; Geo. H. Cook, Henry M. Denton, Edward R. Jones, James S. Kendall, Freeman D. Bewley, William Duryea and C. E. Travis, directors.

THE WALKER MANUFACTURING COMPANY, of Cleveland, O., reports among some of the larger orders taken already this year the following: The Complete Electric Construction Company, New York City, two 50-kw belted lighting generators; The Rahway Electric Railway Company, Rahway, N. J., one 100-kw belted generator and double car equipments, 25-hp steel motors; the Schuylkill Electric Railway Company, Pottsville, Pa., three 400-kw belted generators with switchboard apparatus and two double car equipments, 25-hp steel motors; Saginaw Consolidated Street Railway Company, Saginaw, Mich., one 200-kw belted generator and six complete car equipments, 25-hp steel motors; Hartford & West Hartford Street Railway Company, Hartford, Conn., two double car equipments, 50-hp steel motors, and two double car equipments, 25-hp steel motors; Waukesha Street Railway Company, Waukesha, Wis., one 150-kw belted generator, and three double car equipments, 50-hp steel motors; the Detroit Railway, Detroit, Mich., two 400-kw direct coupled generators, and one 750-kw direct coupled generator; Gloucester, Essex & Beverly Street Railway Company, Gloucester, Mass., two 225-kw direct coupled generators and 16 double car equipments, 25-hp steel motors; The Jasper County Electric Railway Company, Carthage, Mo., two 200-kw belted generators and five double car equipments, 30-hp steel motors. Besides the foregoing the company has taken orders for its spring-mounted steel motors for the Louisville Railway Company, Louisville; Atlantic Avenue Railway Company, Brooklyn; Steinway Railway Company, Brooklyn; Ottumwa Electric Railway Company, Ottumwa, Iowa; Aurora Street Railway Company, Aurora, Ill.; Bloomington City Railway Company, Bloomington, Ill.; Kansas City Railway Company, Kansas City, Mo.; Atlanta Electric Railway Company, Atlanta, and many others. Large orders have also been booked for general work, among which might be mentioned a contract for four 2,000-ton steam and hydraulic cotton compressors for Mr. W. W. Bierce, Montgomery, Ala.

Business Notices.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

THE SYRACUSE STORAGE BATTERY COMPANY desires to test, in fair competition, a street car of their equipment with a similar car, or cars, equipped by other storage systems, for 60, 80, or 120-mile trips; the number of trips, and the street railway on which the test is made to be mutually agreed upon by the storage companies interested. The award of merit to be made by a committee who have no interest in any of the storage batteries to be tested. The committee to be made up as follows: One member to be chosen by each of the following named papers: ELECTRICAL WORLD, *Electrical Engineer*, and one member by the street railway company represented. Address all communications, C. L. Pack, Secretary, Syracuse Storage Battery Co., 38 and 39 Herald Building, Syracuse, N. Y.

DEFECTIVE MACHINERY.

To the Editor of The Electrical World:

Sir:—In a recent issue of the *Iron Age*, under the head of "Machinery," there appeared an article concerning the settlement of suits between Fielding & Platt, of England, and the Morgan Engineering Company, wherein they say that the Morgans agreed to forego a verdict of $10,600 and pay $4,500 besides.

It is true that we obtained such a verdict on the ground of defective machinery furnished by Fielding & Platt, but the $4,500, which was an undisputed balance of account due from us, was deducted therefrom, leaving a net verdict in our favor of $6,100. It is not true that after the argument in New York there was any prospect of the court disturbing our verdict. It was very evident that Judge Hammond, who tried the case, would support the verdict in our favor, and knowing this to be so, the representatives of Fielding & Platt proposed a settlement which, with modifications, we accepted. In this suit, after a long trial, the jury had found as above stated.

At the same time another suit was pending by Fielding & Platt against us, wherein they claimed many thousands of dollars as royalties, on what was called "Tweddell's System." The settlement was this: First, Fielding & Platt had paid substantially all the costs (a large sum) in both suits to date of settlement, and this they released; second, Fielding & Platt released us from all alleged claims for royalties, and dismissed both their suits; third, each party paid one-half the remaining costs, being a small sum; fourth, we paid the balance of account due from us.

We should not feel at liberty to state the terms of settlement but for the evident fact that the article in question emanated from the other side. It will at once be seen that the terms of the settlement were entirely satisfactory to us.

Very truly yours, MORGAN ENGINEERING COMPANY,
per T. R. MORGAN, SR., President.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED FEBRUARY 26 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

534,631. AUTOMATIC ALARM CHECK AND GUARD; A. F. Carpenter, St. Louis, Mo. App. filed May 31, 1894. A closed casing adapted to contain a cushion of air at the top provided with a lateral water discharge opening near its lower end, and an outlet opening having a pipe extension upward beyond said discharge opening a shoulder projecting inward to form an opening of nearly the same area as the mouth of the said extension, and providing an annular passage to the lower portion and discharge opening of the casing, and an alarm check and suitable operative connections therefor, a supply pipe, an interposed air chamber and a break check between alarm check and supply pipe.

534,639. PRINTING TELEGRAPH; S. V. Essick, Brooklyn, N. Y. App. filed Sept. 18, 1890. In a transmitter for a printing telegraphic system, a power impelled shaft provided with spirally arranged stop pins, a series of pivoted key levers one for each pin; a series of sliding keys; a locking bar for locking any one or all of said keys in a depressed position; an escapement carried by the rotary shaft, a pole changer operatively connected with the shaft; a polar magnet having an armature carrying an escapement pallet and electrical connections.

534,642. RAILWAY SUPPLY SYSTEM; H. F. Gray, Passaic, N. J. App. filed Aug. 8, 1893. The combination of two sets of conductors or contact points on the road bed arranged in two distinct lines, one set constituting the working contact or conductor and the other a supplemental conductor, both normally insulated or disconnected from the line and from the ground, an operating switch coil in a connection from one conductor or contact in one set to one in the other, a connection from one of said conductors to the contact of the switch that is operated by a magnet to connect said contact with the line, and means for transmitting the power current from one supplemental contact to another.

534,650. ELECTRICALLY ACTUATED COMBINATION LOCK.; S. L. G. Knox, Camden, N. J. App. filed April 13, 1894. An electric lock motor having a rotatable shaft provided with a scapewheel, a combination lock-gearing connective of said motor and said lock, electrically actuated escapement mechanism for controlling the speed of the lock motor, bolt operating mechanism a series of circuits leading from the outside to the inside of the said safe or compartment and including sources of electricity and the mechanisms.

534,662. ELECTRIC RAILWAY SYSTEM; H. A. F. Petersen, Milwaukee, Wis. App. filed Nov. 8, 1893. An underground conduit for electric railway conductors comprising a suitable casing divided into a plura ity of longitudinal passages or compartments, one of which is arranged to communicate at intervals with a sewer, and provided in its upper wall with a longitudinal slot and another of said passages being arranged to contain the conductors and provided with a longitudinal opening, a suitable cover arranged to normally close said opening, blower mechanism arranged to discharge into the passage, containing the conductors, an electric motor for actuating said blower, a switch for controlling the motor, and a suitable device, sensitive to moisture and adapted to operate the switch to stop or start the motor automatically.

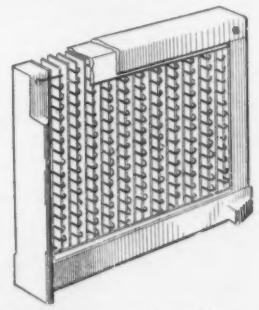
534,663. UNDERGROUND CONDUIT FOR ELECTRIC RAILWAYS; H. A. F. Petersen, Milwaukee, Wis. App. filed March 26, 1894. A conduit arranged to extend longitudinally adjacent to one of the track rails and located wholly beneath the surface of the ground and wholly outside of the line of track, said conduit being divided into two longitudinal compartments, one of which is provided in its upper wall with a longitudinal slot for the admission of a carrier, and the other compartment being arranged to contain the electric conductors and communicating with the first mentioned compartment by means of a longitudinal opening and a vertical and lateral adjustable contact carrier adapted to normally extend outside of the line of the car, and through the longitudinal slot in the upper wall of the first compartment containing the conductors and provided with contact devices for engagement with said conductors.

534,670. TELEGRAPH AND TELEPHONE SYSTEM; C. A. Rolfe, Chicago, Ill. App. filed Sept. 16, 1893. The combination of a main line, a neutral line, means for connecting the two lines at one or more substations and telephones or the like at the main station arranged for connection respectively with the right and left of the lines.

534,671. FIRE ALARM TELEGRAPH SYSTEM; C. A. Rolfe, Chicago, Ill. App. filed April 10, 1894. In a signal-transmitting system, a signal mechanism having a suitable releasing device, a local battery and a normally closed auxiliary circuit including said battery and releasing device, and a local house alarm and a magneto-generator, both likewise included in said normally closed circuit, and a make and break device operated by the signal transmitting mechanism and arranged for making and breaking the auxiliary circuit when the signal transmitting mechanism is operated, the said releasing device being operated, the signal transmitting mechanism by an impulse from the magneto-generator sent over the circuit and supplemental to the local battery current, and the said local or house alarm being sounded by reason of the operation of the signal mechanism, and also by reason of a break in the local circuit from any other cause.

534,677. ELECTRIC ARC LAMP; H. O. Swoboda, New York, N. Y. App. filed April 6, 1894. In an arc lamp, the combination of a magnet for controlling the carbon support of the said lamp, windings or coils for energizing the magnet and a movable piece consisting of an armature independent from and actuated by the pole piece or pieces of the carbon support controlling magnet to make or break the circuits of said one of said windings or coils.

534,678. ELECTRIC CURRENT TRANSFORMER.; J. A. G. Trudeau, Ottawa Can. App. filed April 6, 1894. A combination of a cylinder or drum provided with bars having their ends extending past each other, two groups of contact brushes, and a conductor connecting brushes, the two groups being arranged in such relation to the two drums and to each other that two of the brushes of one group shall bear upon one bar and two of the brushes of the other group shall bear upon another bar all at the same time.



NO. 534,699—ELECTRIC RESISTANCE CARD.

534,699. ELECTRIC RESISTANCE CARD; Alton J. Shaw, Muskegon, Mich. App filed Dec. 1, 1894. A resistance card, block, or section, comprising an open frame a separate cap or bar applied to said frame and forming one wall thereof, and a conductor mounted within said frame and held in place by the detachable cap or bar.

534,729. COMMUTATOR; D. P. Thomson, Schenectady, N. Y. App. filed Dec. 17, 1894. A commutator segment for a dynamo-electric machine having a cut in its upper surface not extending to the end of the segment, and adapted to receive the lead or conductor.

534,731. METHOD OF AND MEANS FOR PREVENTING MAGNETIC LEAKAGE; E. Thomson, Swampscott, Mass. App. filed Feb. 6, 1893. A device for preventing magnetic leakage between the coils of an alternating electric current apparatus, consisting of an endless conductor placed out of the normal primary field but adapted to be cut by the lines of force when deflected from their normal position.

534,732. CONNECTOR FOR ELECTRIC CONDUCTORS; R. D. Titcomb, Schenectady, N. Y. App. filed Dec. 21, 1894. A connector or coupling for electric conductors, composed of two interchangeable parts, each having a tubular body, a knife blade contact registering with a recess upon the other part, a hole in each part, and a pin in the hole, a part of the pin upon one part being cut away to permit the insertion of the corresponding pin upon the other part.

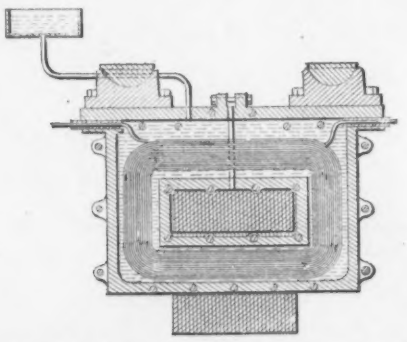
534,777. CONCENTRATOR AND AMALGAMATOR FOR PRECIOUS METALS H. Baudouin and J. Southern, of Grass Valley, Cal. App. filed June 14, 1894. An apparatus for working ores, pulp or gravel containing valuable precious metals, consisting of a pan having an inclined bottom with annular overflow quicksilver channels and copper plates disposed with relation thereto, so that the pulp flows over and against them, and means for producing an electric current through said plates, a discharge gate at the lower periphery of the pan, a sieve or screen extending over the top of the pan, a central hopper from which material is delivered to pass over said screen, and a discharge opening and gate in line with the surface of the screen whereby the finer material is separated by the oscillations of the pan to pass through the screen and the coarser material is discharged through the gate above the screen.

534,779. SIGNALING SYSTEM; C. H. Brace, Union City, Mich. App. filed Nov. 27, 1894 A system having a series of movable signal characters for conveying intelligence and a series of stops respectively registering with such characters and a detent, operated by an electro-magnet adapted to engage any one of the stops at the receiving station, of means at the sending station in the circuit of the said electromagnet, comprising a circuit closer consisting of a triangular movable electrical conductor, the movement thereof practically isochronal with the movement of the signal characters in combination with a stationary contact point adapted to contact the moving conductor and close the circuit and then open the same.

534,785. METHOD AND APPARATUS FOR INSULATING ELECTRICAL CONDUCTORS; L. W. Downes, Providence, R. I. App. filed Aug. 22, 1894. The process of manufacturing insulated electrical conductors, which process consists in coating a wire with adhesive substance, wrapping it with fibrous asbestos, brushing the fibrous coating to raise the nap, compressing it between pressure rolls, coating with waterproof material, and subjecting it to a final rolling to produce a smooth finished surface.

534,786. APPARATUS FOR MANUFACTURE OF INSULATED ELECTRICAL CONDUCTORS; L. W. Downes, Providence, R. I. App. filed Dec. 11, 1894. The combination with a rotating disc mounted upon a hollow shaft through which the covered wire is fed, of a carding-wheel for operating upon the covered wire, mounted upon and rotating with said disc a short shaft passing through the disc carrying at one side of the latter a pinion on the carding wheel, whereby the latter is revolved as it is rotated about and in contact with the circumference of the covered wire.

534,802. ELECTRIC METAL WORKING APPARATUS; Hermann Lemp, Lynn, Mass. App. filed Dec. 3, 1892. The combination in a converter of a primary



No. 534,802.—Electric Metal Working Apparatus.

having a number of turns and a secondary consisting of a sealed metal tube enveloping the primary coil and containing oil.

534,815. ELECTRIC SLOT FOR SIGNALS; J. P. Coleman, Swissvale, Penn. App. filed Sept. 27, 1893. In an electric slot or signals, the combination of a movable slide connected to the signal, a pivotally mounted arm adapted to engage the slide, a pivotally mounted block provided with an extension adapted to push the arm toward the slide, a signal operating lever connected to the block and an electro-magnet for holding the arm in engagement with the slide.

534,826. SIGNAL; E. H. Goodman, Pittsburgh, Pa. App. filed Oct. 25, 1894. The combination of a movable signal blade, two series of electric lamps mounted on the movable blade and having different colored globes, said series being arranged in independent circuits, and means operative on a change in position of the signal for closing one circuit and opening the other circuit.

534,834. BATTERY SYSTEM FOR ELECTRIC RAILWAYS; E. Julien, Brussels, Belg. App. filed Dec. 9, 1886 In combination with a charging table and a number of drawers or boxes of accumulators thereon, terminals on the said drawers or boxes connected with the accumulators and contact plates on the table having each independent connection with a charging circuit, under control of a suitable interrupter or switch, whereby any battery can be withdrawn from the charging circuit without affecting the others.

534,851. DRIVING MECHANISM FOR DYNAMOS LOCATED ON RAILWAY CARS; W. L. Bliss, Brooklyn, N. Y. App. filed Aug. 17, 1894. In combination a car truck, a friction wheel thereon, a dynamo mounted on the car truck, a dynamo shaft mounted to rotate in suitable bearings, spur wheels on the dynamo shaft, a yoke having a swinging movement on the bearings, as a pivot, said yoke carrying a countershaft having spur wheels engaging with the spur wheels on the dynamo shaft, a friction wheel on said countershaft engaging the friction wheel on the car axle and springs engaging the yoke for holding the friction wheels snugly together as the truck and car approach and recede from each other.

534,852. ELECTRIC ARC LAMP; J. Brockie, Forest Hill, Eng. App. filed Nov. 13, 1894. An electric lamp with a carbon rod provided with a rack of a feed wheel for actuating the same, said feed wheel being provided with a spiral rim and operating to rotate a pinion gearing with said rack, a lever provided with a projection adapted to engage said spiral rim and an armature connected to said lever and operating to throw said projection into and out of engagement with said rim.

534,908. ELECTRIC SIGNALING APPARATUS; B. J. Noyes, Boston, Mass. App. filed July 5, 1892. The combination with a message-recording instrument located at a main station and one or more signal transmitters located at substations adapted to transmit two different classes of signals one of which includes a prolonged change in the condition of the circuit and an electric signaling circuit connecting them, of a bell or other indicating device also located at said main station having a striking lever, a toothed wheel to actuate it, driven by a normally wound train and an electric magnet affected by said prolonged change in the condition of the circuit which controls the operative connection of the circuit between said toothed wheel and striking lever.

534,953. DYNAMO-ELECTRIC MACHINE; R. Eickemeyer, Yonkers, N. Y. App filed June 7, 1888. A combination of a set of counterpart coils annularly arranged, electrically connected together, and directly connected to a limited number of commutator bars, and other commutator bars which are electrically connected in groups to those bars, with which said coils are directly connected.

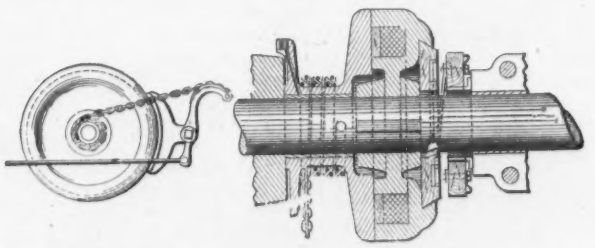
534,956. ELECTRIC TROLLEY RAILWAY; J. M. Hammill, Aldan, Pa. App. filed Jan. 23, 1894. A combination of a slotted conduit and a conductor located therein, a shield interposed between slot and the conductor, a trolley wheel having flanges and trolley arm bent around shield, and having throughout an external insulating coating or covering and an outer casing surrounding that portion of the insulated trolley arm which passes through the slot of the conduit.

534,970. TELEGRAPH AND TELEPHONE SYSTEM; C. A. Rolfe, Chicago, Ill. App. filed Feb. 15, 1893. The combination of the main signal line having branches, the neutral line, the main or central office telephone and a switch comprising contact points arranged in pairs and connected up with said telephone, a couple of contact points connected with the right of the neutral line and one branch of the main line, and the other branch of the main line with a series of levers to establish connection between points.

534,971. INCANDESCENT LIGHT; Henry F. Rooney, Randolph, Mass. App. filed Nov. 17, 1894. A combination of a central reflector, pear-shaped, provided with longitudinal parallel grooves made V-shaped and extending throughout the length of the main portion and each line of the filaments is set opposite the groove and follows it longitudinally for its entire length, said lines of filament being set at a suitable distance from the corner of centre of the grooves to provide two reflectors.

534,974. ELECTRIC BRAKE; Elmer A. Sperry, Cleveland, O. App. filed Jan. 30, 1894. In a brake for a car, a rotating axle, a portion upon such axle presenting a surface organized to be gripped, a stationary gripping mechanism for such rotating portion having a co-operating surface, a groove in one of the surfaces, and a solid lubricant in said groove.

534,975. APPARATUS FOR ARRESTING MOTION OF ELECTRICALLY PROPELLED MECHANISM; E. A. Sperry, Cleveland, Ohio. App. filed Feb. 5, 1894. A combination with an electric motor, of a rheostat or variable resistance, means for cutting off all communication between the motor and the source of electric supply and suitable means other than the motor or its



No. 534,975.—Apparatus for Arresting Motion of Electrically Propelled Mechanism.

parts for maintaining the direction of the current through the field magnets the same when the motor is used as a generator as when used as a motor, and for directing the current so generated through the said rheostat, a local circuit and a brake magnet coil for said local circuit.

534,977. ELECTRIC BRAKE; E. A. Sperry, Cleveland, O. App. filed June 8, 1894. A brake for revolving machinery presenting a wearing face upon one side, means for the support of the brake magnet independent of the revolving element, abutments from the other side of the magnet approaching the revolving part, means mounted upon the revolving part for guiding the magnet and a wearing plate or portion between the guide and the abutments.

534,986. CONDUIT ELECTRIC RAILWAY; M. F. Flynn, Stamford, Conn. App. filed May 24, 1894. In an electric railway, the combination with the closed conduit and the line wire therein of the trolley rail on the conduit having contact surfaces above the line wire, tilting levers arranged below the line wire and adapted to carry the wire upward against the contact screws, and an operating mechanism extending from the levers up through the conduit in the path of the trolley for actuating the levers by the movement of a passing trolley.